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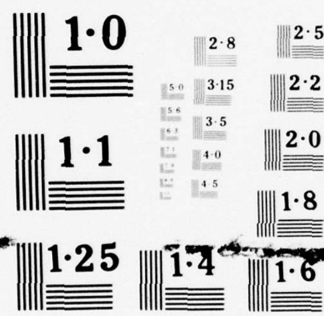

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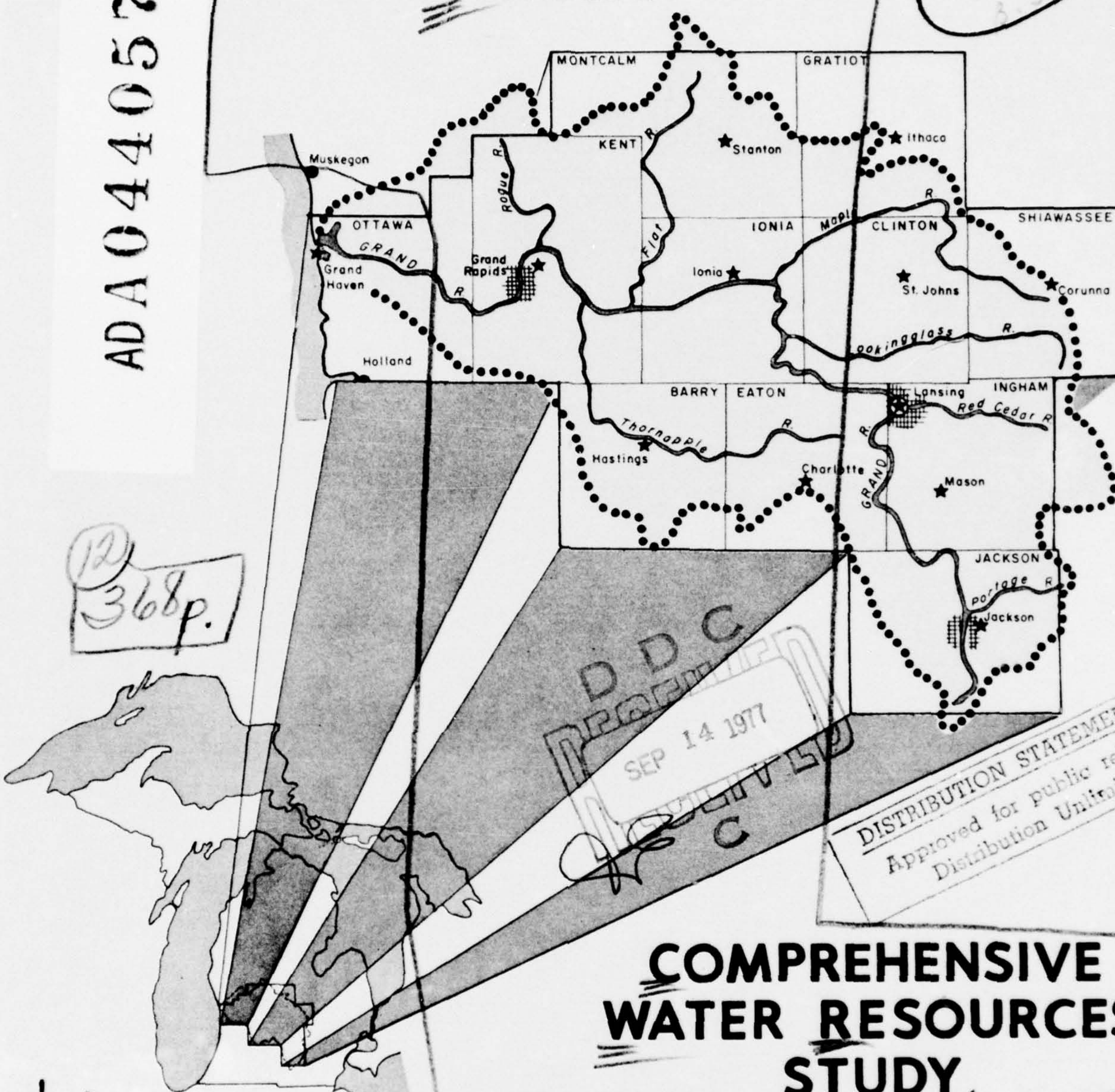

368 p.

COMPREHENSIVE WATER RESOURCES STUDY

VOLUME VII

APPENDIX J — RECREATION

APPENDIX K — FISH AND WILDLIFE

APPENDIX L — POWER

Prepared Under Supervision of the

GRAND RIVER BASIN COORDINATING COMMITTEE

Chairmanship: U. S. Army Engineer District, Detroit

May 1970

410372

APPENDIX J

OUTDOOR RECREATION IN THE GRAND RIVER BASIN MICHIGAN

Prepared for
U.S. Army Engineer District
Corps of Engineers
Detroit, Michigan

by

United States
Department of the Interior
Bureau of Outdoor Recreation
Lake Central Region
Ann Arbor, Michigan

April 1970

This appendix presents an outdoor recreation plan for the conservation, development, and management of the water and related land resources of the Grand River Basin. It has been prepared by the Bureau ot Outdoor Recreation, in cooperation with the State of Michigan, as a field level contribution to the Grand River Basin Comprehensive Study under the general supervision of the Grand River Basin Coordinating Committee.

This is one of a series of appendices to the main report of the Grand River Basin Comprehensive Study. Each appendix deals with a particular aspect of the study. The main report presents a summary of the information contained in the appendices plus the findings, conclusions, and recommendations of the Grand River Basin Coordinating Committee.

These appendices and the main report are subject to review by the Governor of the State of Michigan, by the interested Federal agencies at the departmental level, and by the Water Resources Council prior to transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

SYLLABUS

The Grand River Basin, containing 5,572 square miles and draining to Lake Michigan, lies in the southwest part of Michigan's lower peninsula. The basin is composed chiefly of undulating ground moraine of Wisconsin origin interlaced with areas of gently rolling hills and level plains. The climate is humid continental, modified to some degree by the influence of Lake Michigan. A recreation season of 14 weeks was used to project summer demand.

About eight percent of the land is urbanized, while most of the remainder is in agricultural and forest uses. Dairy and general farming, together with specialty crops in local areas, comprise the principal agricultural uses.

A population of about 1.1 million in the Grand River Basin makes up 14 percent of the State's population. Nearly 63 percent of the basin's population is urban and is concentrated about Jackson, Lansing, and Grand Rapids. The rapid population growth of the recent past is expected to continue. The amount of leisure time available for outdoor recreation is expected to increase at a faster rate than the increase in population. All modes of transportation are well developed within the basin. The area is easily accessible from all directions to those from outside areas who seek recreational opportunities within the basin.

The 1960 average family income ranged from $5,147 in the West Central Subarea to $6,241 in the Jackson Subarea. The average basin family income was $6,080, or about $460 above the national average.

Recreation demand was evaluated for the basin as a whole and for the five individual subareas--Jackson, Lansing, West Central, Grand Rapids, and Northeast--as defined for the Comprehensive Water Resource Study. It was calculated by applying selected per capita participation rates to the effective population expected to recreate in the basin. The demand for each subarea is assumed to originate from the population in the subarea; plus the SMSA population outside of, but within 125 miles of, the subarea border; plus the non-SMSA population outside of, but within 40 miles of, the subarea boundary. Sixty percent of the expressed demand is expected to be satisfied within 40 miles of its point of origin as day-use. Thirty percent of the demand will be satisfied within 125 miles of the SMSA as overnight or weekend-use.

Three water-dependent activities--swimming, boating, and water skiing--and two water-enhanced activities--camping and picnicking--were used to determine basic demand. Demand produced by sightseeing, nature walks, and hiking was computed as a percent of basic demand and added to that demand to obtain gross demand. Demand for fish and wildlife opportunities were developed in a separate appendix.

Demand was converted from visitor occasions to a resource base through the application of design load standards. The resource base used was the number of acres of developed land and water surface needed to accommodate a given number of participants.

It was assumed that developed acres of land would represent between 10 and 20 percent of the total need for land. The other 80 to 90 percent is needed to separate activities and to provide the necessary open space or buffer and to provide space for those activities not evaluated. To assure safe conditions and protection to shorelines, water within 300 feet of shorelines was not considered to be usable for powerboating and water skiing except at launching points. Care must be exercised to avoid overdevelopment of a resource to prevent its ultimate destruction by overuse.

Demand figures for all activities computed for the years 1960, 1980, 2000, and 2020 show a six-fold increase for the basin between 1960 and 2020. Increases in individual activities for this period vary from slightly less than a five-fold increase for picnicking to nearly an 11-fold increase for camping. Total demand less existing supply and programmed development, provides needs for each of the periods studied. Actual supply, or potential capacity, was measured in developed acres for each activity and not on visitation estimates. Programmed development was obtained from county and State plans for planned recreational facilities.

Exclusive of water, the greatest need for recreation land by 2020 is for development of facilities for camping and picnicking. Based on an average development level of 15 percent, nearly 60,000 acres of land, exclusive of water surface, will be needed for all recreational facilities. The Lansing Subarea shows the greatest need for recreation facilities in the basin.

It is questioned whether the need for water for recreational use together with other needs for water can be met in this basin. Therefore, participants in water-dependent activities will probably have to: (1) accept lower standards for space, (2) seek opportunities elsewhere, and/or (3) seek to satisfy their desires in other activities.

Existing State and county parks, inland lakes, Lake Michigan, and streams all have some additional potential for development. The private sector could also provide additional facilities.

Of the 187 reservoir sites proposed by the Corps of Engineers and the Soil Conservation Service, 33 were determined to have significant potential for the development of new recreational facilities. The Grand River Valley, especially between Lansing and Lake Michigan, has much potential for recreational development.

Factors considered in the appraisal of reservoir sites include: (1) capacity of the site to satisfy the needs of people, (2) facilities development potential, (3) variety of recreational opportunities available, (4) size and quality of pool, and (5) aesthetic qualities. Criteria for evaluation of land for recreational use include: (1) amount and location of existing forest cover, (2) suitability of soils, (3) character of relief, and (4) extent of existing development.

Goals include: (1) an adequate supply of quality water for recreationists, (2) water of such quality to permit full body contact, (3) stability of water levels, (4) sufficient quantity of recreational facilities within reasonable driving distance from those who use them, (4) opportunity for a quality experience, and (5) coordination of recreation programs with other related land and water uses.

A recreation plan consisting of a mixture of: (1) the completion of several new State parks and recreation areas and the expansion of several existing State parks, (2) the acquisition and development of several sections of the Grand River Valley for recreation, (3) the development of new recreation areas on reservoirs, and (4) the continuing acquisition of public access on inland lakes. It is estimated that this plan would satisfy about 60 percent of the 1985 needs.

The recreation plan proposes a total of 12 reservoirs, one in the Jackson Subarea, three in each of the Lansing, Northeast, and West Central Subareas, and two in the Grand Rapids Subarea. Two valley preserve developments are proposed: one on the Grand River above Grand Rapids and one on the Grand River above Lansing. Other proposed developments include additions to the Ionia Yankee Springs, and Waterloo Recreation areas; the Hoffmaster, Newaygo, and Sleepy Hollow State Parks; and public access sites on lakes presently without it.

Water for recreation may be made available by: (1) providing access to and otherwise developing the potential of existing lakes and streams, (2) improving the quality of existing water, (3) controlling the rate of sedimentation, (4) constructing reservoirs, and (5) developing methods to re-use water.

Regulatory measures to protect existing streams and lakes include: (1) water quality control standards, and (2) land use zoning. There is a need to preserve existing areas with high aesthetic qualities.

Benefits were determined from the projection of 1985 needs and a monetary value of $1.25 per recreation day was used for each subarea and the basin as a whole.

Cost estimates were based on acquisition and development of land and the construction of reservoirs necessary to meet projected needs for 1985. Total

costs were calculated for recreational facilities. Average equivalent costs were derived from these figures.

Cost of facilities for the proposed development is estimated at $52 million dollars, land costs are estimated to be nearly $8 million dollars, and reservoirs would be about $36 million dollars for a total estimated cost of about $96 million dollars.

In summary, there is a need for development of recreational facilities in all of the subareas, but the Lansing and Northeast Subareas are especially short of recreational opportunities.

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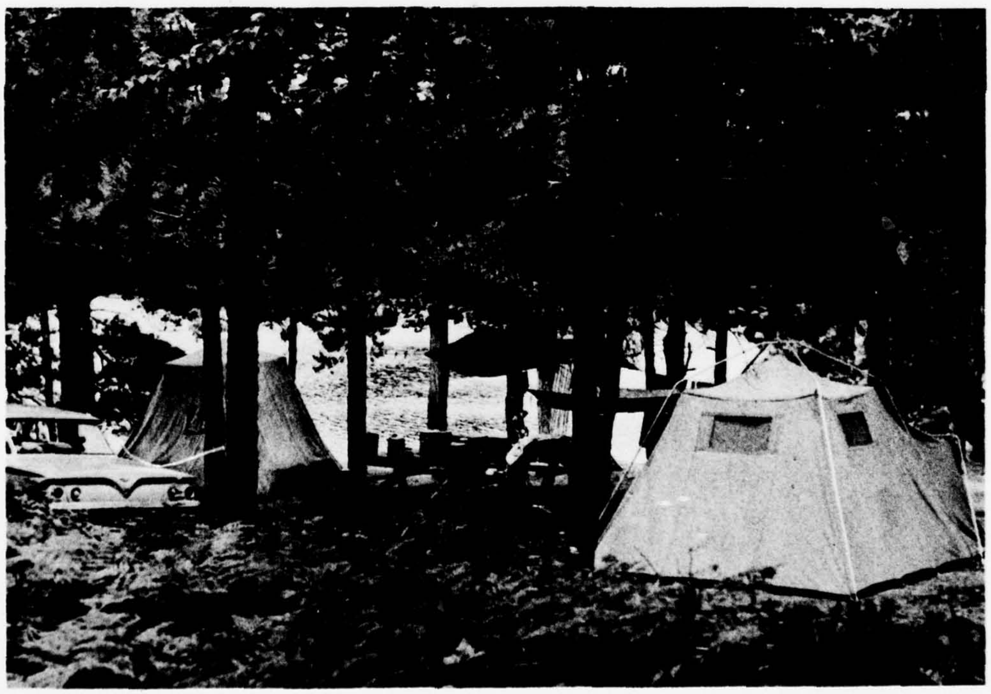


Proper use of land is important if we are to maintain our land resources and meet the needs of people. (Photo courtesy of Michigan Department of Natural Resources)

SECTION I

INTRODUCTION

1. AUTHORITY. The survey of the Grand River Basin, Michigan, has been made in accordance with a request from the Corps of Engineers, U. S. Army Engineer District, Detroit, on June 18, 1963. Through the Secretary of the Interior, the Bureau of Outdoor Recreation has been given the responsibility to conduct the recreation study under authorization of the Act of May 28, 1963, (77 Stat. 49; 16 U.S.C. 460 l et seg.). This Type II comprehensive study is being conducted under the authority of the Water Resources Council established under the Water Resources Planning Act (79 Stat. 244; 42 U.S.C. 1962).

2. PURPOSE. The basic objective of this Type II study is the formulation of a plan for the development of outdoor recreation that can be integrated into the utilization of existing and potential water and related land resources of the Grand River Basin.

The purpose is to be realized through: (1) inventory of existing and programmed water-oriented recreation areas; (2) identification of potential recreation areas; and (3) establishment of needs and goals on a priority basis for recreational development to the year 2020, with emphasis on the next ten to fifteen years.

3. SCOPE. The recreation study provides an inventory of existing water oriented, nonurban, public facilities for outdoor recreation administered by Federal, State, and county agencies. The study determines the present and projected demands and needs, and culminates in the presentation of specific proposals of development in accordance with principles expressed in Senate Document 97, administrative directives expressed in House Resolution 5269, and Public Law 89-72.

4. BACKGROUND. This report represents the first comprehensive study of outdoor recreation in the Grand River Basin. Previous studies explored the potential for flood control, navigation, and major drainage improvements only. Detailed information concerning the basin's water resources has been compiled in a bibliography for the Grand River Basin Data Book prepared and distributed by the Corps of Engineers.

5. BASIC ASSUMPTIONS. The following general assumptions have been made for the preparation of this report: (1) population and economic growth of the basin will proceed at the rates indicated in the economic base study; (2) if land and water is provided to fulfill the demand for these five selected water-oriented outdoor recreation activities, namely: swimming, boating, water skiing, camping, and picnicking, it is believed that there will be sufficient resources avail-

able to meet the space needs for development of other outdoor recreation activities within the basin, and (3) this study was not designed to recommend ways of providing recreation facilities, especially swimming and picnicking, in urban areas.

6. ACKNOWLEDGEMENTS. Data were supplied by the Federal and State agencies participating in the comprehensive study of the Grand River Basin. Information was also obtained from the various planning authorities of Jackson and Kent Counties and the Tri-County Planning Commission of Clinton, Eaton, and Ingham Counties.

SECTION II

GENERAL DESCRIPTION OF STUDY AREA

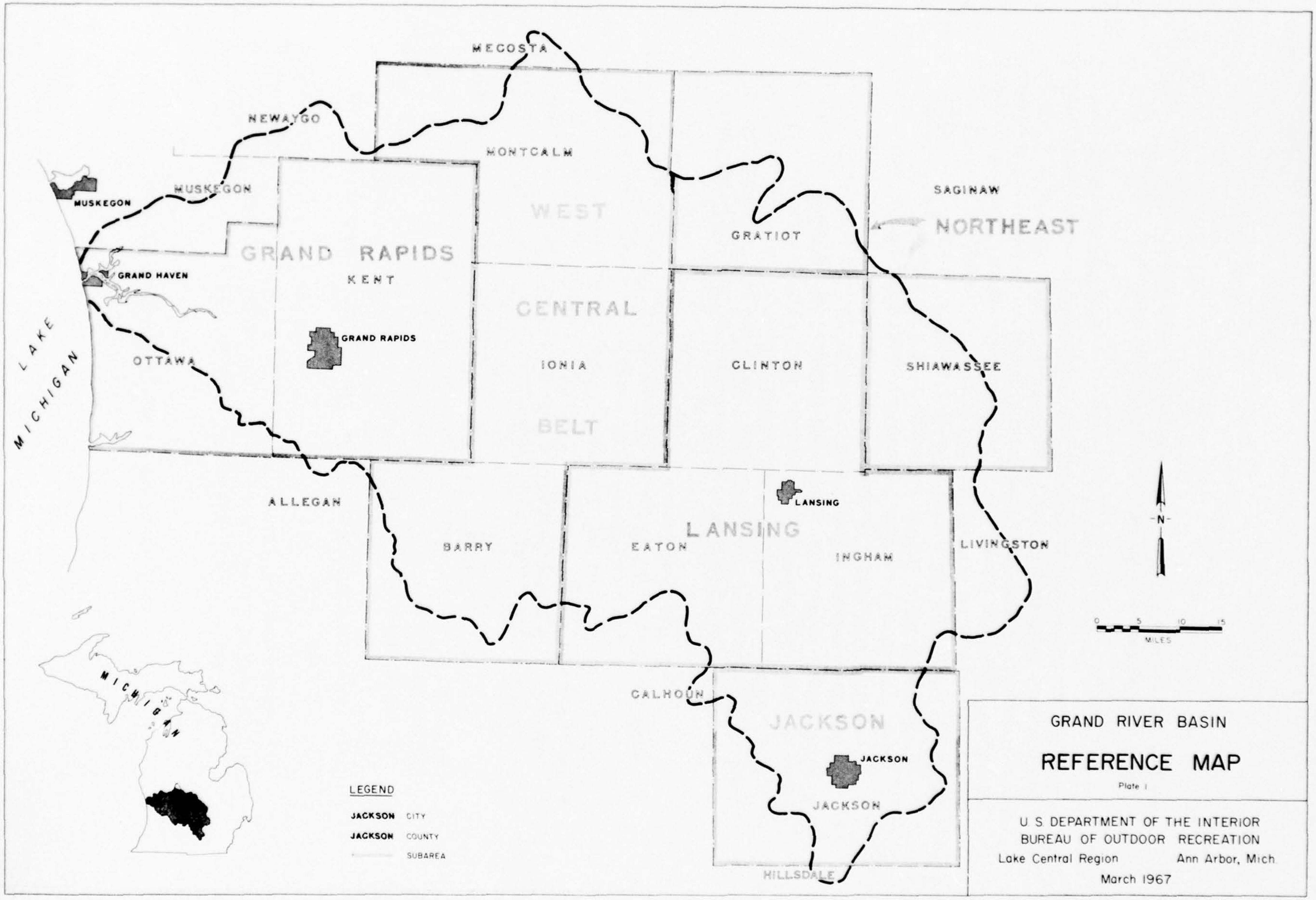
7. PHYSICAL. The physical features of any area have a direct effect on the utility of resources in that area for specific purposes. In this study it is essential to examine each of the principal physical features and its relationship to the field of outdoor recreation.

a. Location. Location of an area with respect to population centers is very significant from the planning point of view. The Grand River Basin contains several major centers of population within its boundaries and has two of the Nation's largest Standard Metropolitan Statistical Areas (SMSA), as well as a number of smaller ones near its boundaries. It lies directly in the path of development of the midwestern megalopolis.

The Grand River Basin, a part of the Lake Michigan drainage system, is situated in the southern portion of Michigan's lower peninsula. The nearly oval shaped basin has a length of 135 miles and a maximum width of 70 miles. The drainage area of the Grand River and its tributaries is 5,572 square miles. The basin has six major tributaries: the Rogue, Flat, and Maple Rivers enter from the north; the Thornapple River enters from the south; and the Looking Glass and Red Cedar Rivers enter from the east.

The Grand River Basin study area has been defined as an 11-county area (6,770 square miles) that includes: Barry, Clinton, Eaton, Gratiot, Ingham, Ionia, Jackson, Kent, Montcalm, Ottawa, and Shiawassee Counties. These 11 counties were grouped by their common similarities into five distinctive subareas as defined by the economic base study. The Grand Rapids Subarea includes Ottawa and Kent Counties; the West Central Subarea is composed of Montcalm, Ionia, and Barry Counties; Jackson County is identified as a subarea; the Lansing Subarea is identified as Ingham, Clinton, and Eaton Counties; and the Northeast Subarea consists of Gratiot and Shiawassee Counties. See Plate 1 for delimitation of subareas and location of the Grand River Basin in Michigan. Only about one-half each of Gratiot and Shiawassee Counties lie within the basin boundaries. They exert a minimum of influence on demand for outdoor recreation in the Grand River Basin. However, these counties are located between Standard Metropolitan Statistical Areas on the southwest and on the northeast and east which generate substantial demand for recreational opportunity.

b. Relief. Areas with substantial and interesting relief provide picturesque settings for recreational activities. Recreational experiences obtained



GRAND RIVER BASIN

REFERENCE MAP

Plate I

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
Lake Central Region Ann Arbor, Mich.
March 1967

in such areas usually have much higher quality than those found in a near featureless landscape.

The land features of the Grand River Basin were formed during the recession of the Saginaw and Lake Michigan lobes of the Wisconsin glacier. As the glacier alternately advanced and retreated, ground moraines, recessional moraines, glacial outwashes, and other glacial features developed. Contemporary with and subsequent to the glacial retreat, drainage channels became established and produced the relief along their courses. Such relief is especially prominent along the Grand River downstream from Lansing.

Much of the basin is covered with a nearly level to undulating ground moraine which is weakly dissected randomly with occasional low lying, nearly level outwash plains underlain with gravel and sand. The ground moraine consists largely of sandy loam, loam, or clay loam till. Interspersed among these large expanses of ground moraine are extensive areas of rolling, hummocky, recessional moraines. They are composed of a heterogeneous mixture of gravel, sand, and till of varying textures. These features are well expressed in Barry, Jackson, Kent, and Montcalm Counties. Parts of Gratiot and Shiawassee Counties consist of low lying, nearly level glacial lake plains consisting of moderately fine textured lacustrine sediments capped with an intermittent thin mantle of sands.

In many areas the lack of relief limits the potential for the development of recreation areas. These nearly level areas have limited potential for the development of high quality water impoundments and they lack aesthetic appeal. On the other hand, the more rolling relief in morainic areas provides sufficient aesthetic qualities to enhance recreational experiences in such areas.

c. Soils. Soils in the basin are the heritage of Pleistocene glaciations. A complex soil system has developed in the surface of the glacial parent material. Although sandy loam is the predominant soil type throughout the basin, the soils vary from fine textured clays in the northeastern section, through medium textured soils of the central and southern areas, to the sandy soils of the northern and western sections of the basin. Locally, mucks and peats are prominent. Variations in soil types are evident in the developed land-use patterns.

Many of the soils in the basin can support a broad range of recreational activities. However, several exceptions should be examined. The poorly drained soils of the glacial till plain are slow to dry out in the spring and after rainfall. Muck soils have poor stability and are usually very wet. The very sandy soils, such as the dunes along Lake Michigan, are quite drouthy

and support only a very fragile community of plant life which cannot withstand heavy traffic by recreationists.

d. Climate. Climate determines the length of the primary recreation season as well as the principal activities in which one can participate. The moderating influence exerted by the prevailing westerly winds over Lake Michigan results in warmer winters, cooler summers, and delayed arrival of spring and fall on the western portion of the basin with continued, but diminishing effect in the eastern portion.

The basic recreation season for the area extends from late May through early September and is equivalent to a 14-week summer vacation season. The average daily minimum temperature for June, July, and August is 58 degrees F., and the three-month average daily maximum is 81 degrees F. Days of 90 degrees F. occur infrequently in Ottawa and Kent Counties, while farther inland 18 or 20 days above 90 degrees F. may occur during each summer.

The heaviest rainfall occurs in May, June, and September. Precipitation of 0.01 inch or more may be expected in 28 days from June through August in the western subareas and during 18 days for the same period in the eastern subareas. The normal annual rainfall is 31 inches for all parts of the basin.

The prevailing westerly winds across Lake Michigan bring cloudiness and snow flurries during the period from November to April. Near Lake Michigan 70 to 80 inches of snowfall are common, while inland the amount of snowfall averages between 35 to 40 inches.

Generally, the climate in this basin is conducive to a broad range of recreational activities. Rainfall, cloudiness, and occasional periods of cool weather, are the primary restrictive factors during the summer recreation season.

e. Land use. The land-use heritage of the Grand River Basin is quite different from much of the rest of Michigan. While white pine was king in northern Michigan, the Grand River Basin settlers were busy harvesting hardwoods. From 1840 to 1900 farmers and loggers cleared the good farm land and built an important furniture industry from some of the timber; a substantial portion of it was burned.

Today, the basin's agricultural character still persists, but some changes have occurred as shown in Plate 2. Industrial growth has become important, and urban areas now occupy approximately eight percent of the land. Nearly two-thirds of the land in the 11-county area is presently used for pasture and cropland. Dairy and general farming are the major uses of the agricultural land. Onions, berries, mint, and celery are important crops where soil conditions are favorable. Fifteen percent of the land is forested, and the majority of these 536,000 acres occur in small scattered farm woodlots.

Plate 2--*With the passage of time, there have been substantial changes in land use in some areas of the Grand River Basin.* (Photo courtesy of Michigan Department of Natural Resources)

Although a large percent of the land in the Basin is in agricultural and related uses, there are numerous areas of land that are now marginal for agriculture. Other areas are in forest or lying idle. Many of these areas could support a broad range of recreational uses. The better adapted are restricted largely to the more rolling, morainic relief.

8. SOCIO-ECONOMIC. The increased demand for outdoor recreation has been attributed to increasing population, more leisure time, greater mobility, higher income, and their associated demographic characteristics. These are measurable societal factors useful for predicting future outdoor recreation demand, but they are not the only elements that should be considered. Advertising, education, the increased pace of our modern way of life, and the emphasis on a status system all encourage an increased desire for more outdoor recreation activity. However, the effect of these factors can only be recognized since they are difficult to measure.

a. Population. The 1960 Grand River Basin population was approximately one and one-tenth million people and comprised 14 percent of the Michigan resident population. Population will continue to grow rapidly and steadily into the 21st Century. See Table 1 for projections by subareas. The population density, while not uniformly distributed, averaged 162 persons per square mile. See Plate 3 for distribution of population within the basin.

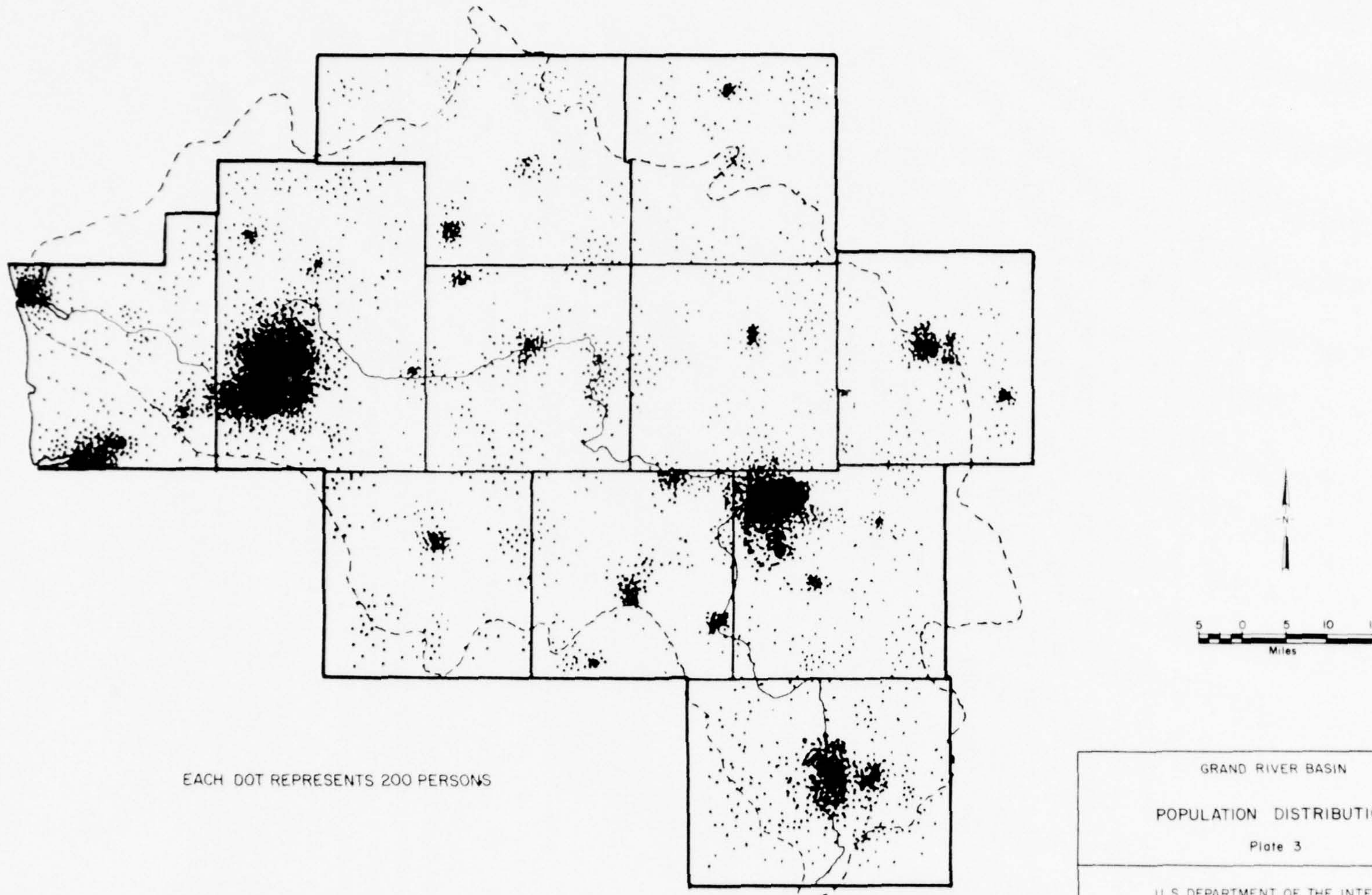
Table 1

PROJECTIONS OF POPULATION BY SUBAREAS

1960 - 2020
(1,000's)

Subarea	1960	1980	2000	2020
Jackson	132.0	177.0	250.7	338.7
Lansing	298.9	434.8	626.6	867.6
West Central	110.7	142.8	184.0	233.3
Grand Rapids	461.9	635.6	900.1	1,242.6
Northeast	90.4	115.6	154.2	198.8
Total for Subareas	1,093.9	1,505.8	2,155.6	2,881.0

Population growth rates have been greatest in those areas with the highest population densities, indicating a continuing trend toward urbanization. At the present time, 62.7 percent of the basin's population is urban and is concentrated about Grand Rapids, Jackson, and Lansing. The West Central Subarea and the Northeast Subarea have lesser populations and are growing at a slower rate.



EACH DOT REPRESENTS 200 PERSONS

SOURCE: *The Grand River Basin and its Economic Future, 1960-2020 (Draft)*
Battelle Memorial Institute, April 1965, page 37

GRAND RIVER BASIN

POPULATION DISTRIBUTION

Plate 3

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
Lake Central Region Ann Arbor, Mich.
March 1967

b. Leisure Time. The Outdoor Recreation Resources Review Commission (ORRRC) studies indicate one-fifth of all leisure time is spent in outdoor recreation pursuits, several of which are illustrated in Plate 4. It is assumed that this rate will be maintained, if not increased, in the future.

Employment in agriculture in the basin is decreasing, while manufacturing, contract construction, and nearly all other categories of employment are increasing. The anticipated result of this shift from a resource-based employment to an industrialized atmosphere is a population desiring more outdoor recreation opportunities. This employment shift will likely provide a work week that is regulated by union contract which will result in more leisure time to participate in outdoor recreation. At the present time, employment in forestry and fisheries is decreasing also, but it is anticipated that the trend of employment in forestry will change to an increasing one in the near future. It is conceivable that, if salmon fisheries develop as contemplated, employment in fisheries could also change to one of increase.

c. Transportation. A study of Michigan tourism conducted by Central Michigan University noted "Michigan's tourists do not frequent the southern counties to any great degree, but move farther north for their tourist activities." This study indicated that an important segment of the basin's vacation visitation originated outside of Michigan. A logical assumption of origin would be the states along Michigan's southern border--Ohio, Indiana, and Illinois.

The people in all of the states indicated above, including Michigan, are highly mobile. They do not hesitate to travel up to 125 miles or more for a weekend of recreation. The availability of more free time and more uncommitted income in future years in addition to an improved interstate highway system will probably result in an increase in mobility. Such an increase could result in an inflow of greater numbers of people in future years than is present now, also a greater outflow from this basin than occurs now.

Accessibility to the basin for the recreationist is provided by airports, Lake Michigan marinas, railroads, and a good highway system. The interstate highway system is the primary mode of transportation. The important southern routes entering the basin from Illinois and Indiana are Interstate 94, U.S. 131, and U.S. 27. Ohio residents are connected with the basin via U.S. 127 and U.S. 223 to the Jackson Subarea. Excellent access for Detroit residents is provided by the east-west Interstates 94 to Jackson and 96 across the basin to Lake Michigan. U.S. 23, U.S. 31, and Interstate 69 serve as important feeder routes from Ohio and Indiana.

A number of major highways provide good access to recreation areas north of the basin for those basin residents who desire recreational opportunities in that area. The major routes include U.S. 27 north from Lansing, U.S. 131 and State 37 north from Grand Rapids, U.S. 31 north from Holland, and Interstate 96 northwest from Grand Rapids.

This interstate highway system combined with an extensive network of State and county highways provides good mobility within the basin and across basin boundaries. The Jackson, Lansing, and Grand Rapids populations are linked by limited access highways and State and county roads exit from these main arteries to assure accessibility to all areas within the basin.

d. Income. The increased demand for outdoor recreation has been partially attributed to larger income. This rise could, in part, be due to greater opportunities, or it might be a measure of our social class system where participation in outdoor recreation activities can bring prestige and status.

Mueller and Gurin stated that ". . . among people who engage in outdoor recreation the major barriers in greater use of outdoor recreational facilities away from home are at present financial. It follows that if income increases in the years ahead and more people get vacations with pay, there will be a very large rise in the demand for outdoor recreational facilities for vacation and weekend use."

The 1960 median family income ranges from $6,421 in the Jackson Subarea to $5,147 in the sparsely populated West Central Subarea. The weighted median basin family income is $6,080, or about $460 above the national average.

The people of the Grand River Basin, with a higher family income level than that of the nation as a whole, would be expected to participate in outdoor recreation to a slightly greater extent than the average U.S. citizen. This has been considered in the projection by increasing the per capita participation rate for each activity by four percent.

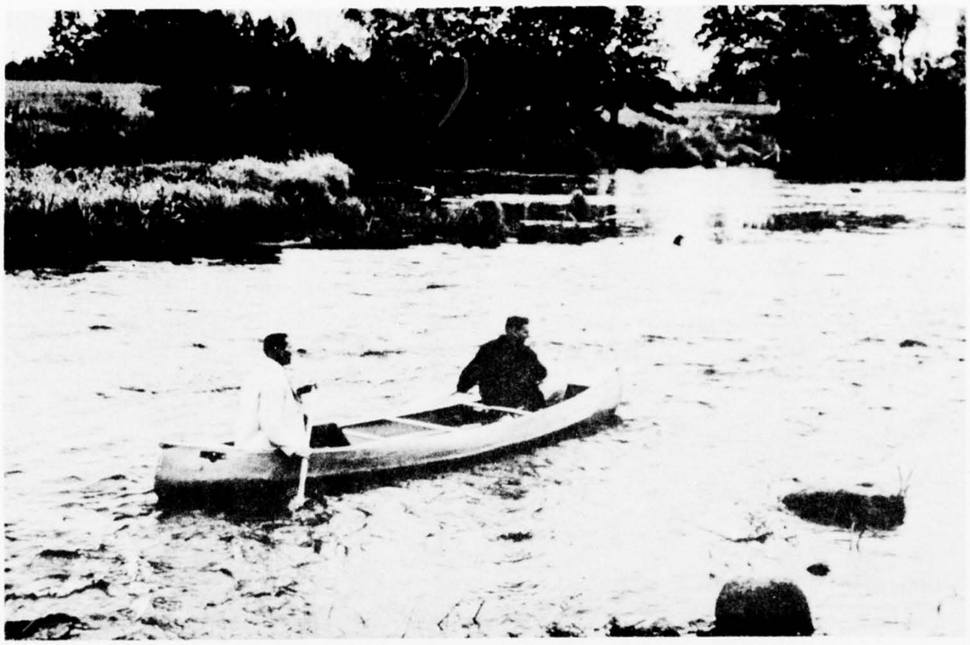


Plate 4--*Leisure time is utilized in a variety of ways.* (Top photo courtesy of U.S.D.A., Soil Conservation Service; Bottom and page J-13 photos courtesy of Michigan Department of Natural Resources)

SECTION III

DEMAND, SUPPLY, AND NEEDS

9. RECREATION MARKET AREA. The recreation market area is considered as that zone of influence from which the majority of people recreating in the Grand River Basin originate. The recreation market area for each subarea is assumed to consist of the Standard Metropolitan Statistical Areas (SMSA) and rural, or non-SMSA, population residing in the subarea, plus the SMSA population outside the basin but within 125 miles of the subarea boundary, plus the non-SMSA population outside of, but within 40 miles of, the subarea boundary.

The recreation service area extends outward from the center of the population of a specific geographic area. It encompasses the recreation resources which serve or are expected to serve the residents of a specified geographic area.

10. DEMAND. The current and future demand for outdoor recreation in the Grand River Basin, as well as for each subarea, was estimated in order to determine the extent and preference of the population to participate in water oriented activities.

Recreation demand is a measure of the amount of outdoor recreation opportunity, in recreation days, that the public desires. Demand is assumed to radiate equally in all directions from the center of concentration of population of a given SMSA except as noted below. The non-SMSA demand is assumed to radiate equally in all directions from the center of population in that county, or where no significant population center exists, from the geographic center of the county.

Theoretically, the generated demand can be prorated to the subareas on the basis of distance between the subarea boundary and the SMSA or non-SMSA involved. This input demand is considered to be of three different levels. It is predicted that 60 percent of the expressed demand will occur as day use within a recreation service area with a radius of 40 miles from that SMSA or non-SMSA. An additional 30 percent of expressed demand from an SMSA will be satisfied within 125 miles as overnight or weekend use. The 30 percent originating from non-SMSA counties were not distributed because of very small numbers involved. The final 10 percent is expected to travel more than 125 miles to find recreational opportunities.

Where more than 10 percent of the distributed effective population from SMSA areas or non-SMSA counties fell across international boundaries or over major bodies of water, adjustments were made to redistribute such populations equally over the remainder of the area within that recreation service area.

The redistribution of effective population falling on Canadian land resulted in an average increase of less than four percent in effective population in the basin.

The demand computed by this SMSA method is a potential demand that assumes all conditions to be equal. In reality, other factors such as the transportation network, advertising, and site quality, tend to determine the actual outdoor recreation pattern from any given SMSA. As a result the potential demand from an SMSA could be assigned to one recreation subarea, while the actual population might participate in another subarea. The bulk of the demand for day use activities should be met in or near the subarea of origin, but it may be necessary, and justifiable, to supply a surplus of recreational opportunities in one subarea for the benefit of an adjacent population where opportunities for development of recreational facilities are limited.

Demand was calculated by applying selected per capita participation rates to the effective population input assigned to each of the basin subareas. The study obtained per capita participation rates from the Outdoor Recreation Resource Review Commission (ORRRC) Reports No. 19 and No. 26. If total population were considered, it would be necessary to increase the demands set forth in this report by about 25 percent to include that segment of the population under 12 years of age.

a. Effective population. The effective population composed of persons 12 years of age and older is computed from the recreation market area of each subarea in the basin. Total effective populations of each subarea are given for each year of projection in Table 2. See Appendix A for methodology on the development of effective population figures. The projected populations are based on area growth rates as determined by the Economic Base Study.

Table 2

PROJECTIONS OF EFFECTIVE POPULATION

BY SUBAREA

Subarea	Actual Population (1,000's)	Effective Population (1,000's)			
	1960	1960	1980	2000	2020
Jackson	132.0	76.3	105.0	147.6	200.9
Lansing	298.9	176.7	243.1	341.7	465.3
West Central	110.7	192.7	265.2	372.7	507.4
Grand Rapids	461.9	144.9	199.4	280.2	381.5
Northeast	90.4	131.4	180.8	254.1	346.0
Basin Total	1,093.9	722.0	993.5	1,396.3	1,901.1

b. Activities. Two major phases of water-oriented activities shown in Plate 5, have been considered in the study: water-dependent and water-enhanced. Water-depended activities include swimming, water skiing, and boating (includes all pleasure boats, fishing boats, canoes, and sailing craft). Major activities considered as water-enhanced are camping and picnicking. Sightseeing, nature walks, and hiking, while generally enhanced by water, are only considered in the computation of total recreation demand. Hunting and fishing and related resource demand data are furnished in a separate report compiled by the Bureau of Sport Fisheries and Wildlife, U.S. Department of the Interior.

The degree of visitor participation for each activity was determined from per capita use rates expressed in ORRRC Reports No. 19 and No. 26. They were adjusted to the socio-economic characteristics of the basin for the selected planning years of 1980, 2000, and 2020. They are presented in Table 3 and Plate 6. The use of the new 1965 participation rates developed by the Bureau of Outdoor Recreation would increase total demand by about 24 percent for the eight activities used in this report. See Appendix B for methodology on the development of per capita participation rates.

c. Design load standards. The demand for participation in each recreational activity was determined from the expected number of visitor occasions by those individuals who are presumed to look to the Grand River Basin for fulfillment of their outdoor recreation desires during a given season or planning year. Demand can then be converted from visitor occasions to a resource base through the application of design load standards.

Design load refers to the number of people who can be accommodated by a given unit of resource at any one time in such a manner that quality experiences are maintained. The number of summer occasions for any one activity divided by the product of the number of peak days, or summer Sunday equivalents, and the turnover factor yields the design load visitation for planning goal determination in that activity. Turnover is the estimated number of times that a given unit of facility will be used during any one peak day and still maintain a quality experience. Methodology for the determination of the number of peak days is set forth in Appendix C. Design load visitation with respect to resource allocation is meaningless unless it is translated to requirements for acres of land and water. Visitation data were converted to acreage requirements through the application of activity design load standards which should provide the recreation visitor with a reasonable quality of experience.

Plate 5--*Swimming requires water of high quality within easy access for large numbers of people. Picnicking is always a pleasurable activity, especially for the younger ones.* (Photo courtesy of Michigan Department of Natural Resources)

PROJECTED ACTIVITY USE RATE PER CAPITA
OF EFFECTIVE POPULATION

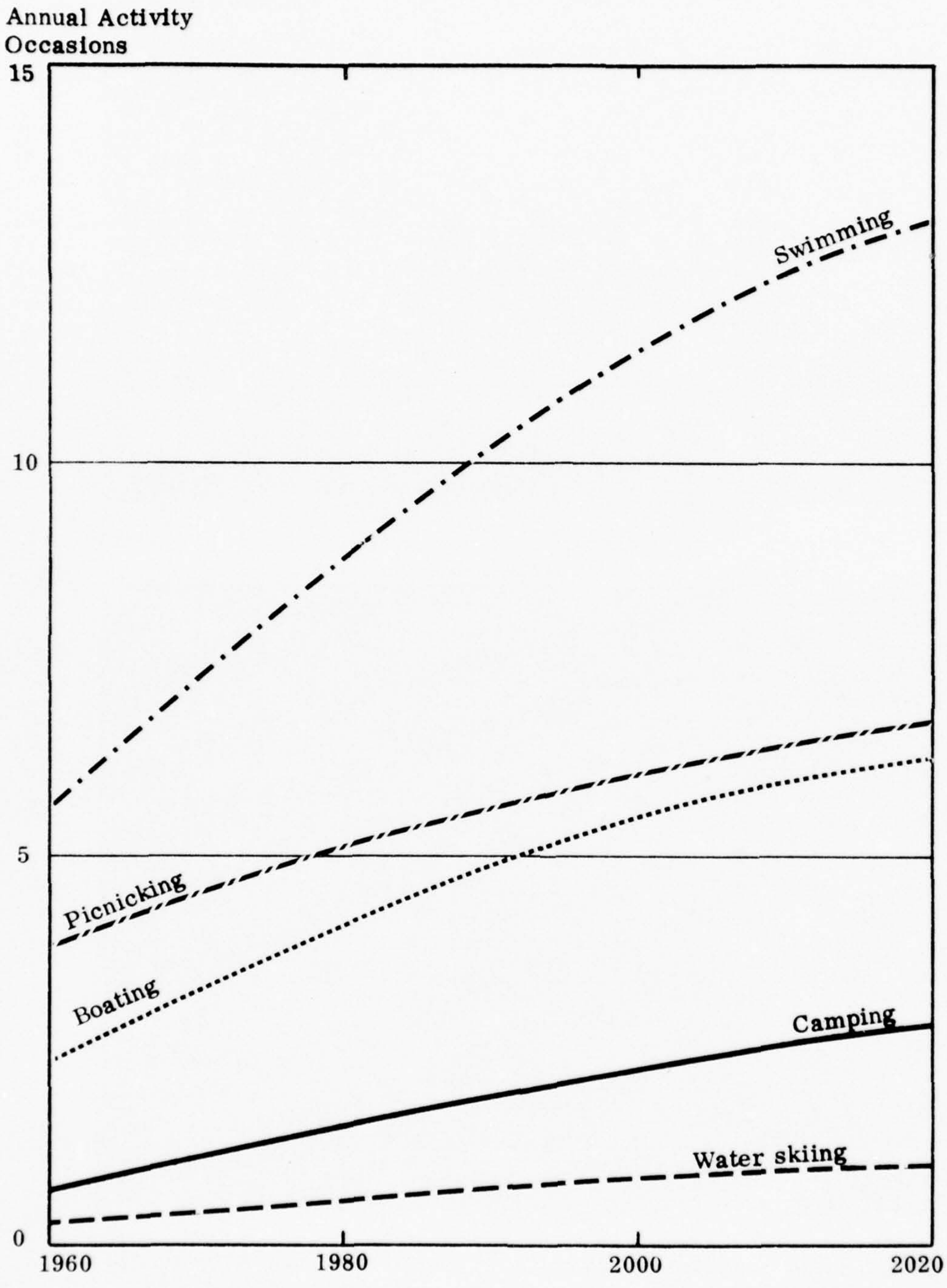


Plate 6

Table 3

ACTIVITY USE RATE

PER CAPITA OF EFFECTIVE POPULATION

Activity	Annual Activity Occasions							
	1960		1980		2000		2020	
	A*	S*	A	S	A	S	A	S
Swimming	5.55	4.81	8.79	7.62	11.35	9.84	12.99	11.30
Boating	2.53	1.66	4.09	2.69	5.39	3.55	6.15	4.05
Water Skiing	0.28	0.22	0.57	0.45	0.83	0.64	0.99	0.77
Camping	0.68	0.42	1.44	0.88	2.24	1.37	2.79	1.72
Picnicking	3.79	2.43	5.07	3.26	5.97	3.84	6.64	4.26
Other Acti-vities	9.79	3.66	16.29	6.35	21.80	8.48	25.85	10.10
Total	22.62	13.20	36.25	21.25	47.58	27.72	55.41	32.20

*A - Annual
*S - Summer

The acreage figures, set forth in the table on Standards for Design, represent only those acres required for development to meet the needs of a given activity. Substantial additional acreage will be needed to separate the activities and to provide the open space necessary for quality recreational experiences. Normally, in nonurban recreation areas, only 10 to 20 percent of a land area should be developed for intensive uses for various recreational activities. The other 80 to 90 percent of the land should be utilized to separate activities, one from another, and to provide open spaces for hiking, sightseeing, and those other activities for which no specific acreage needs were determined. Plate 7 illustrates ideal conditions for such activities. The standards applied in this study are set forth in Table 4.

In areas where the availability of land is limited by cost or other factors, the ratio of one acre of developed land in 5 to 10 acres may need to be adjusted downward somewhat to permit slightly greater intensity of use of the areas as a whole. However, it is our belief that not more than one acre in five should be developed for use.

The standards set forth in Table 4 have been developed to provide a quality experience to the participant and to protect the resources from damage. Space for various activities must be adequate to provide to the recreationist certain minimum standards for safety, health, and privacy. The safety factor is especially important in such activities as boating, water skiing, and swimming.

Plate 7--*These types of activities are best adapted to the relatively undeveloped portions of recreation areas. They require extensive areas of open space.* (Photo courtesy of Michigan Department of Natural Resources)

Table 4

STANDARDS FOR DESIGN

Activity	Visitors/ Unit	Unit Size	Visitors/Acre	Turn-over
Swimming	1 Visitor/ Unit	100 Sq. Ft. Beach	435 Visitors/Land Acre	2
Boating	3 Visitors/ Boat	6 Water Surface Acres/ Boat	1 Visitor/2 Water Surface Acres	2.5
Water Skiing	3 Visitors/ Boat	24 Water Surface Acres/ Boat	1 Visitor/8 Water Surface Acres	6
Camping	5 Visitors/ Site	8 Sites/Acre	40 Visitors/Acre	1
Picnicking	5 Visitors/ Site	10 Sites/Acre	50 Visitors/Acre	2
Parking	4 Visitors/ Car	87 Sites/Acre		varies by activity
Parking with boat trailer, includes ramp	3 Visitors/ Car	33 Sites/Acre		varies by activity

In planning for water skiing, as shown in Plate 8, and powerboating activities, the water within 300 feet of the shoreline cannot be considered usable for such activities, except where boats are launched and loaded. Such restrictions are needed to protect boaters and skiers, for the protection of shores from wave action caused by boats and skiers and for the protection of shore or near shore recreationists. The amount of space required for boating varies substantially with the mix of various types of boats. Powerboats and sailboats require much larger areas of surface water to maneuver safely than do rowboats, canoes, or boats with small motors. Figures used in the Standards for Design are an average for all classes of boating. Powerboats need about twelve acres per boat; small boats about two acres per boat. An average mix of three small boats for each two powerboats was assumed for design purposes.

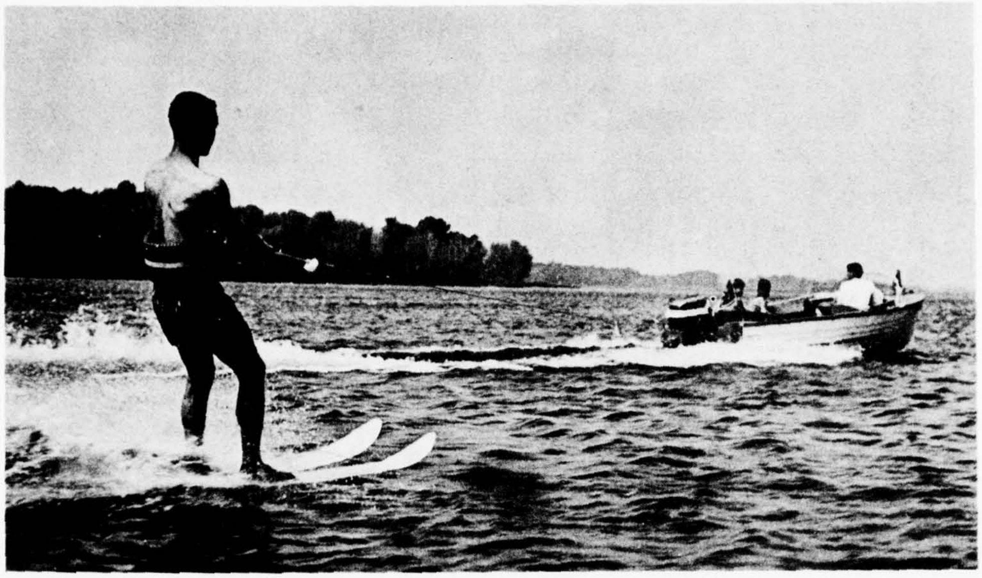


Plate 8--*The demand for surface water for skiing is increasing very rapidly.* (Photo courtesy of Michigan Department of Natural Resources)

In planning for swimming activities, it is assumed that 50 square feet of wet beach is needed for each 100 square feet of dry beach. This additional figure is not included in the Standards for Design since it represents water surface area. It is however, included in estimates of facility costs in another part of this report. It is estimated that nearly one-third of the people on the beach will be in the water at any one time, and of those in the water, one-third will be swimmers. The 50 square feet of wet beach per person will permit 50 and 350 square feet, respectively, for each wader and swimmer actually in the water at any one time.

Soils vary greatly in their ability to withstand the damaging effects of continuous trampling, especially when they are moist or wet. The compaction of soils that is brought about by excessive use results in direct and indirect damages to associated resources. Direct damages include soil erosion and physical damages to vegetation, both the roots and leaves. Indirect damages consist of deterioration of soil structure and decrease in the supply of soil moisture, both of which cause lower plant vigor and ultimately possible death of the plant.

Where recreational activities are not provided with sufficient space, the intensive use of resources by participants results in damage and ultimate destruction of such resources as scenic beauty, soil, and vegetative and other biological life.

d. Demand requirements. The 1960 and projected future demand assumes that all desires for outdoor recreational opportunities oriented to water may be fulfilled at the time they arise. Therefore, it cannot be expected that the 1960 demand figures will correspond with the 1960 visitation estimates from managing agencies. Demand has been computed by subarea to provide a means of demonstrating the areas with the greatest demand.

Since the effective population was based only on persons 12 years of age and older, and since a very substantial amount of demand is generated by persons under 12 years of age, an adjustment was made in the basic demand figures for all activities except boating and water skiing to include demand generated by persons under 12 years of age. It was assumed that these persons would participate at the same rate as those persons 12 years of age and older and that only those persons between the ages of four and eleven would generate demand for space. Therefore, since the number of persons 12 years of age and older in Michigan would need to be increased by 38 percent to obtain the total population of the State, the basic demand figures for all activities except boating and water skiing were increased by 25 percent to include that demand generated by children aged four through eleven.

A comparison of demand with supply statistics will provide a picture of the need for future recreation development by this subarea. The details of the development of demand and need are provided in Appendix D.

The demand for swimming developed in this report represents only that part which normally takes place on beaches. It is estimated that about two-thirds of the total swimming demand will be satisfied in such facilities. The remaining one-third will be satisfied at pool facilities.

Likewise, a small but significant percentage of demands for picnic facilities is satisfied in small local parks, but the development of facilities with a wide range of opportunities will attract much of this demand when they are made available. However, there will still be a need for picnic facilities in urban and small rural parks that are easily and readily accessible to the public.

The acreage of land needed for recreation should be located in close proximity to surface waters. Recreation areas located adjacent to usable water have greater appeal to the recreationist than land devoid of water. Even those activities not directly related to water--hiking and sightseeing--seem to provide greater satisfaction to the participant when such opportunities are provided in close proximity to water than when they are removed completely from it. See Table 5 for projections of demand for the basin including land for parking as shown in Plate 9. It includes projections of demand for five basic activities: swimming, boating, water skiing, camping, and picnicking; and the secondary activities: sightseeing, hiking, and nature

Table 5

BASIN SUMMARY OF DEMAND REQUIREMENTS

Activity	Year	Visitor Occasions Annual (1,000's)	Visitor Occasions Summer (1,000's)	Design Load Visits (1,000's)	Developed Acreage Requirements Land Activities	Developed Acreage Requirements Land Parking	Developed Acreage Requirements Water (1,000's)
Swim-ming	1960	3,338	2,895	42.0	98	120	
	1980	7,277	6,309	90.3	207	260	
	2000	13,204	11,447	164.1	377	469	
	2020	20,558	17,904	256.2	589	732	
Boating	1960	1,827	1,198	13.7		137	27.4
	1980	4,063	2,672	30.6		306	61.2
	2000	7,527	4,957	56.7		567	113.4
	2020	11,692	7,699	88.0		880	176.0
Water-Skiing	1960	202	159	.8		8	6.4
	1980	566	447	2.1		21	16.8
	2000	1,159	894	4.3		43	34.4
	2020	1,882	1,464	7.0		70	56.0
Camp-ing	1960	614	379	10.8	273		
	1980	1,789	1,092	31.1	778		
	2000	3,910	2,392	68.6	1,710		
	2020	6,630	4,088	116.8	2,919		
Picnick-ing	1960	3,421	2,193	31.4	629	89	
	1980	6,295	4,049	57.8	1,159	166	
	2000	10,419	6,702	95.9	1,919	275	
	2020	15,779	10,123	144.3	2,891	413	
Second-ary Acti-vities	1960	8,837	3,305			55	
	1980	20,230	7,887			116	
	2000	38,049	14,802			220	
	2020	61,430	24,001			348	
Sum-mary of all Acti-vities	1960	18,239	10,129	98.7	1,000	411	33.8
	1980	40,220	22,456	211.9	2,144	871	78.0
	2000	74,272	41,195	389.6	4,006	1,574	147.8
	2020	117,971	65,279	612.6	6,398	2,443	232.0

walks. See Table 28 through 32 in Appendix E for demand by subareas. Table 6 (see page 28) summarizes total annual occasions and recreation days by subarea in the basin. See Plates 10 and 11, respectively, for relationship of summer occasions to effective population and demand requirements for the eight major activities.

Plate 9--*Parking areas adequate to handle peak loads and situated to provide easy access to major activities are required to meet the needs of the public.* (Photo courtesy of Michigan Department of Natural Resources)

RELATIONSHIP OF SUMMER OCCASIONS
TO EFFECTIVE POPULATION

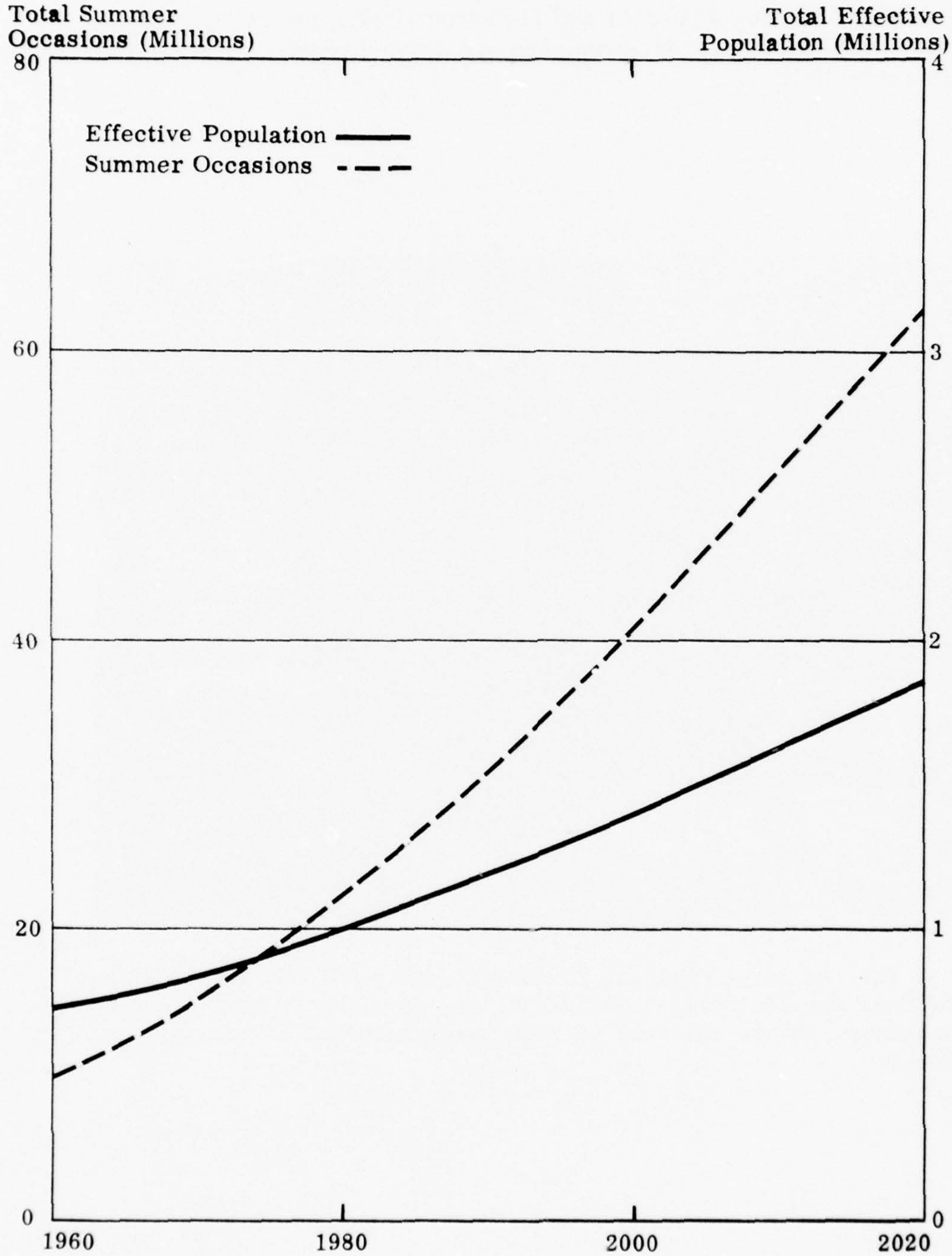


Plate 10

DEMAND REQUIREMENT FOR EIGHT MAJOR ACTIVITIES
BY SUBAREA

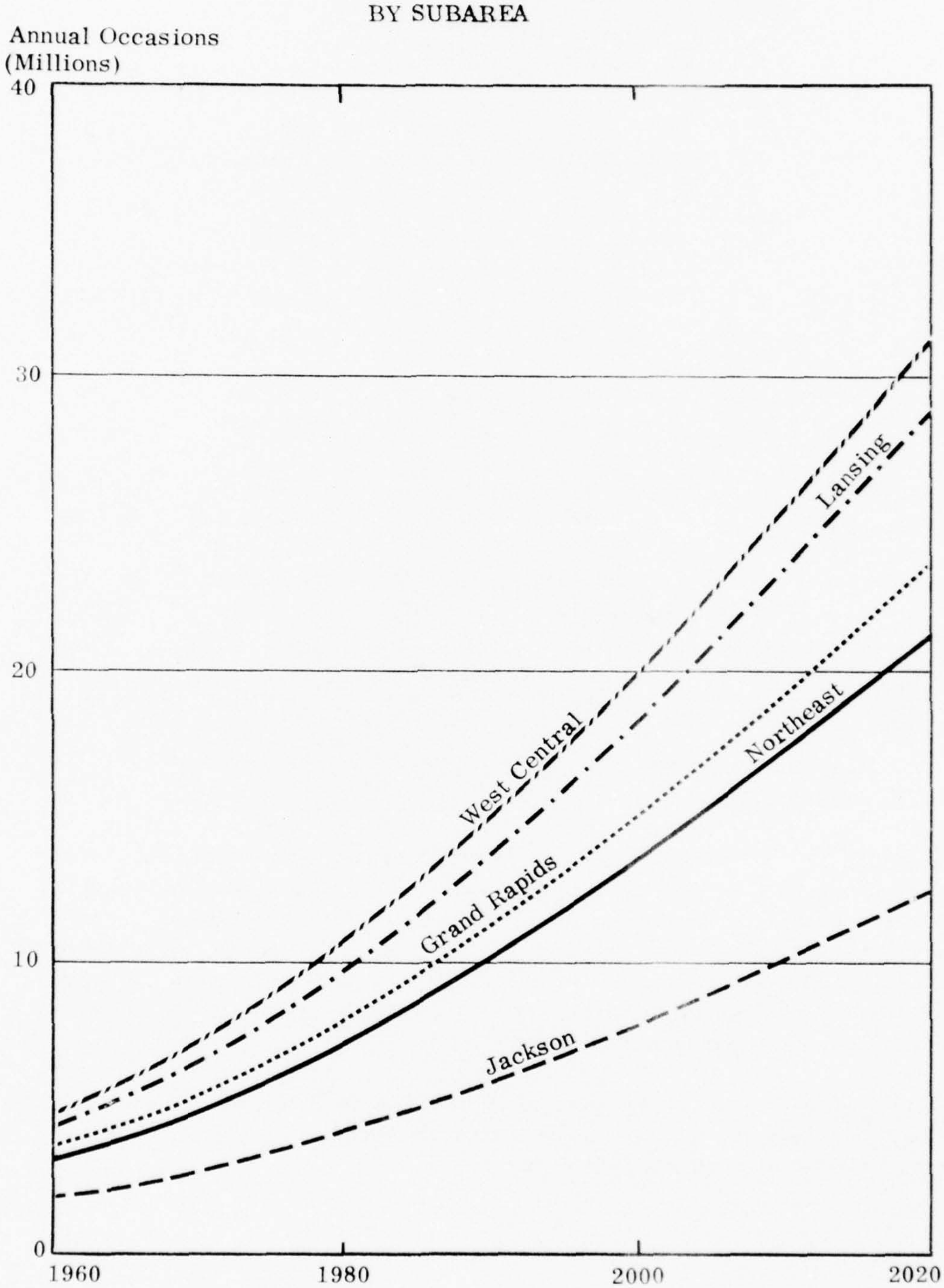


Plate 11

Table 6

SUMMARY OF ANNUAL OCCASIONS AND RECREATION DAYS

FOR ALL ACTIVITIES

BY SUBAREA AND YEAR

Subarea		1960 (1,000's)	1980 (1,000's)	2000 (1,000's)	2020 (1,000's)
Jackson	A.O.*	1,927	4,250	7,851	12,470
	R.D.**	771	1,700	3,140	4,988
Lansing	A.O.	4,464	9,840	18,176	28,880
	R.D.	1,786	3,936	7,270	11,552
West Central	A.O.	4,869	10,737	19,822	32,491
	R.D.	1,948	4,295	7,929	12,996
Grand Rapids	A.O.	3,661	8,080	14,904	23,679
	R.D.	1,464	3,232	5,962	9,472
Northeast	A.O.	3,318	7,318	13,515	21,451
	R.D.	1,327	2,927	5,406	8,580
Total	A.O.	18,236	40,219	74,268	118,970
	R.D.	7,296	16,090	29,707	47,588

* A.O. - Annual Occasions
**R.D. - Recreation Days

11. SUPPLY. The supply inventory is primarily an analysis of public water oriented resource areas in the Grand River Basin. The inventory includes Federal, State, county, and certain municipally administered areas. Those municipal recreation areas containing recreation facilities for one or more of the five major activities considered in this study were included in the supply inventory. Only those oriented primarily toward swimming pools and playgrounds were omitted from the inventory.

Camping facilities on private recreation areas were included in the inventory of supply. Lack of available data on privately operated facilities for other activities precluded an analysis of them.

Private recreation enterprises frequently serve as a holding unit for overflow from public areas and commonly do not provide a rounded recreation experience within themselves. This is not a degradation of the value placed on private recreation areas. In the future, it is hoped that private enterprise may play a more active role in supplying the public with a quality recreation experience.

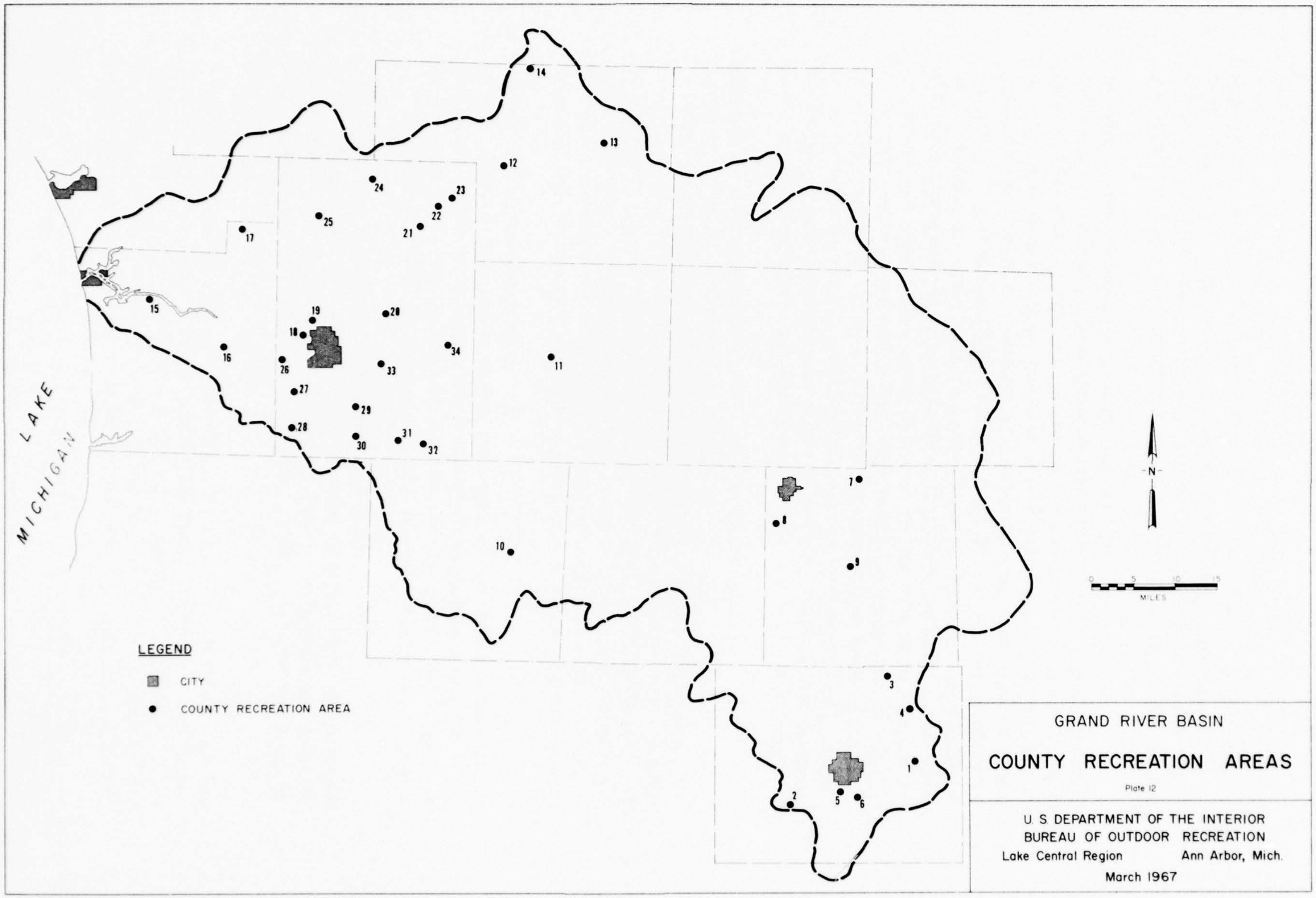
No consideration has been given to the identification, location, and study of archeological and historical areas in this report. These important features have been identified and studied by the National Park Service. Their findings will be included in the Comprehensive Basin Report.

a. Existing supply. The existing supply was inventoried and evaluated on the basis of present development and current unused capacity. The inventory also includes programmed and potential areas with consideration given to type, quantity, and quality of land and water resources now available or suitable for future development.

Actual supply, or potential capacity, is measured in terms of developed acres for each activity and not on visitation estimates. That is, supply figures were derived in acres which could be converted to recreation days with the application of the Bureau of Outdoor Recreation design load standards. This allows the resource base carrying capacity to be interjected in the evaluation of existing sites and provides development guidelines necessary for the provision of a quality experience. See Plates 12, 13, and 14 for location of existing recreation areas. A list of their names is given in Table 7.

Some of the existing State and county parks have relatively light development in relation to total land area available. In part, particularly with relationship to State parks, this is due to the fact that development funds have not been made available. In other cases, key tracts of land remain in private ownership. Much of the land is primarily useful for extensive recreation, and serves the "open space" function which, as indicated on page 20, is the appropriate land use for 80 or 90 percent of the total recreation land. However, southern Michigan State recreation areas do present existing opportunities for additional facilities, especially for picnicking and camping. Where surface water is available, a potential for additional swimming facilities also may be developed. Where it is practical and feasible to do so, all existing park sites should be developed to their maximum potential in accordance with the proposed type of development planned for them and without sacrifice of the potential for a quality experience.

The supply of water surface was determined from lakes larger than 20 acres and from the water surface of the Grand River. Those lakes with developed public access were classified as existing supply. Fifty percent of the surface area of those lakes without public access was included as existing supply


LAKE MICHIGAN
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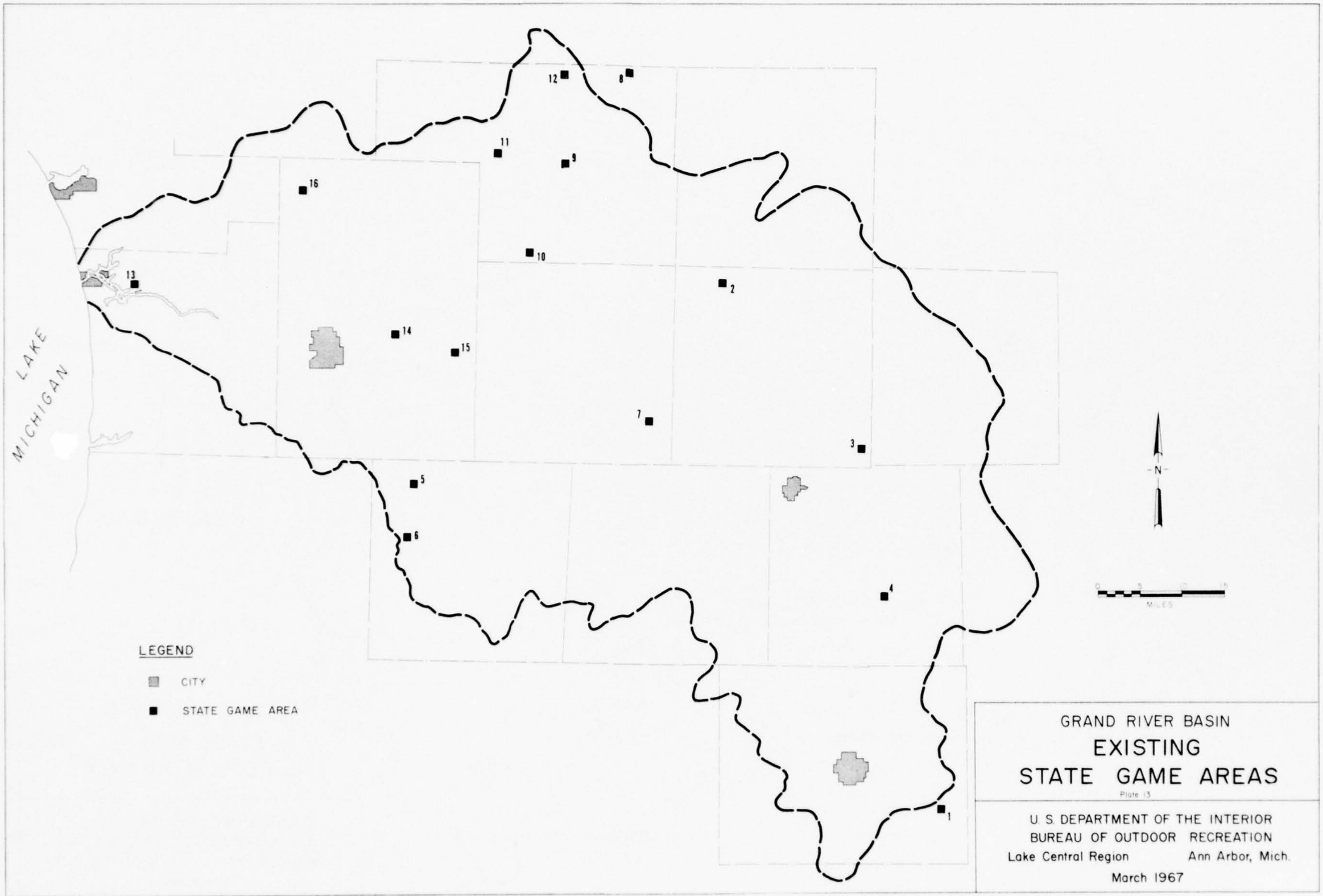
MILES
LEGEND
CITY
COUNTY RECREATION AREA
GRAND RIVER BASIN
COUNTY RECREATION AREAS
Plate 12
U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
Lake Central Region
Ann Arbor, Mich.
March 1967



GRAND RIVER BASIN

EXISTING STATE GAME AREAS

Plate 13

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
Lake Central Region Ann Arbor, Mich.
March 1967

GRAND RIVER BASIN

STATE PARKS AND RECREATION AREAS

Plate 14

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
Lake Central Region — Ann Arbor, Mich.
March 1967

Table 7

NAMES OF EXISTING RECREATION AREAS IN OR NEAR THE GRAND RIVER BASIN

State Parks and Recreation Areas

1. Walter J. Hayes State Park
2. Waterloo Recreation Area
3. Pinckney Recreation Area
4. Brighton Recreation Area
5. Fort Custer Recreation Area
6. Yankee Springs Recreation Area
7. Holland State Park
8. Grand Haven State Park
9. J. P. Hoffmaster State Park
10. Muskegon State Park
11. Sleepy Hollow State Park
12. Ionia Recreation Area
13. Newaygo State Park

State Game Areas

1. Sharonville
2. Maple River
3. Rose Lake Experiment Station
4. Dansville
5. Middleville
6. Barry County
7. Portland
8. Vestburg
9. Stanton
10. Flat River
11. Langston
12. Edmond
13. Grand Haven
14. Cannonburg
15. Lowell
16. Rogue River

County Park Areas

1. Grass Lake Park
2. Lime Lake Park
3. Pleasant Lake Park
4. Portage Lake Park
5. Sparks Park
6. Vandercook Lake Park
7. Lake Lansing
8. Grand River Park
9. Rayner Park
10. Charlton Memorial Park
11. Bertha Brock County Park
12. Flat Rock County Park
13. Krum Park
14. Townline Lake Park
15. Riverside Park
16. Hager Park
17. Grose Park
18. Dwight Lydell Park
19. Plainfield Park
20. Warren R. Townsend County Park
21. Lake County Park
22. White Pine County Park
23. Spencer Park
24. Gordon County Park
25. Longlake County Park
26. Henry A. Johnson Park
27. Linus C. Palmer Park
28. Douglas Walker Park
29. Paris Park
30. Dutton Shadyside Park
31. Caledonia Lakeside Park
32. Coldwater River Park
33. Chief Hazy Cloud Park
34. Fallsburg Park
35. Vineyard Lake Park
36. Swains Lake Park

since some of these lakes provide opportunities to the owner and his friends. The remaining 50 percent was considered as potential supply. The water surface of the Grand River from Lake Michigan to Lansing was included as existing supply, although access to it is rather limited. Tributary streams were not included since they provide only very limited opportunity for boating and practically no opportunity for water skiing. They do provide opportunities for fishing. See Table 8 for existing supply.

Water quality was considered, but it was not permitted to affect the evaluation of supply. Sufficient data is not available to evaluate the quality of water, lake by lake. However, with the intensive residential development on the shores of many lakes, and the lack of central sewage systems around most of them, it is reasonably safe to assume that the quality of the water in many of these lakes has been degraded to some extent by pollutants. It was disclosed recently that even the main body of Lake Michigan waters is being degraded more rapidly than previously surmised.

For the purpose of this planning study, it was assumed that current interest and legislation will ultimately prevent further deterioration of water quality in the lakes and streams of the basin, and this should lead to improved conditions in these natural bodies of water. However, if such legislation and control measures are not established, some of the existing supply of water will be lost for recreational use by a rise of pollutants to intolerable levels.

Table 8

SUPPLY AVAILABLE IN SUBAREAS AND BASIN--1965

Activity	Land Acres	Water Surface Acres
Jackson Subarea		
Swimming	12	
Boating and Water Skiing	9	7,400
Camping	53	
Picnicking	88	
Parking	32	
Lansing Subarea		
Swimming	0	
Boating and Water Skiing	3	1,500
Camping	9	
Picnicking	70	
Parking	7	

Table 8 (continued)

Activity	Land Acres	Water Surface Acres
West Central Subarea		
Swimming	27	
Boating and Water Skiing	25	18,000
Camping	31	
Picnicking	88	
Parking	70	
Grand Rapids Subarea		
Swimming	28	
Boating and Water Skiing	5	11,100
Camping	22	
Picnicking	209	
Parking	35	
Northeast Subarea		
Swimming	0	
Boating and Water Skiing	1	
Camping	0	1,000
Picnicking	5	
Parking	1	
Summary		
Swimming	67	
Boating and Water Skiing	43	39,000
Camping	115	
Picnicking	460	
Parking	145	

b. Private supply. There is no accurate inventory of the supply of recreational facilities provided by the private sector. An attempt was made to evaluate this segment of supply by inventorying the number of campsites published in Woodall's Trailering Parks and Campgrounds. According to this publication, there are 29 private campgrounds providing a total of 680 camping spaces in the 11 counties in this study. They range in size from two to more than 100 spaces each and provide a variable range of services ranging from those that provide a bare minimum to those which provide opportunities for swimming,

boating, fishing, and other outdoor games. Of the 29 sites, nine provide opportunities for swimming, eight for boating, 13 for picnicking, and 12 for other outdoor activities. See Table 9 for a breakdown by subarea.

Table 9

SUMMARY OF CAMPING AND RELATED RECREATIONAL FACILITIES PROVIDED BY THE PRIVATE SECTOR

Subarea	Number of Areas	Number of Camping Spaces	Equivalent Acres of Developed Land	Number of areas providing opportunities for: Swimming	Boating	Picnicking	Other
Jackson	8	253	25	2	2	5	3
Lansing	4	26	3	1	-	1	1
West Central	7	113	11	4	4	4	4
Grand Rapids	10	288	29	2	2	3	4
Northeast	-	-	-	-	-	-	-
Total	29	680	68	9	8	13	12

Based on the design load used earlier in this study, the 680 camping sites are equivalent to 68 acres of developed land. This equivalent was included in the existing supply.

There is no known data that provides specific information on the quantity of facilities provided by the private sector for other types of recreational activities. Therefore, no attempt was made to quantify the extent of facilities available for use for each of the other activities examined in this study. In addition, the use of such facilities is normally limited to individuals who use the camping facilities provided by the private sector. Therefore, the intensity of use of the related recreational facilities would usually be low.

c. Programmed supply. Programmed supply was obtained from the Michigan Statewide Plan, while potential water sites were identified by the Corps of Engineers, Soil Conservation Service, and Michigan Water Resources Commission. Additional information concerning potential recreation areas was gathered during basin reconnaissance trips and personal contact with area and county planning commissions.

Determination of the 1980 unsatisfied demand required identification of the capabilities of future outdoor recreation programs as described in county and State plans. To qualify as a programmed area, an individual project must be planned for development with a site plan and an activity breakdown. Those projects which could be listed only as hopeful acquisitions were not included in programmed supply in the study.

Plans are being developed by the Soil Conservation Service for flood control measures on the upper part of the Maple River under Public Law 566. Two structures are being proposed for flood control and recreational purposes. The Sleepy Hollow site on the Little Maple River is already under development by the State of Michigan. The planned facilities for this site are included in the programmed supply available. The other proposed structure located on Bear Creek will provide a recreational pool of 235 acres. When this site is developed, it also will provide a significant quantity of additional facilities in an area of substantial demand, but with limited opportunity. This site was not included in programmed supply.

The State is also developing a recreation area near Ionia which was included in programmed supply. Newaygo State Park, now being planned, will provide recreational opportunity also, but it was not included in programmed supply because it lies outside of the study area.

Recreational facilities programmed for development were not enumerated by site. Each project was evaluated for its contribution to the required activity facility needs across the basin. As is the case with supply and demand, all computations are expressed in terms of acres of land and water which may be converted to visitor days when required. A summary of programmed development is set forth in Table 10.

Table 10

ACREAGE PROGRAMMED FOR RECREATIONAL DEVELOPMENT BY 1980

Activity	Jackson	Lansing	West Central	Grand Rapids	North-east	Basin Total
Land						
Swimming	0	6	7	9	0	22
Boating and Water Skiing	2	5	3	7	0	17
Camping	21	26	45	54	0	146
Picnicking	31	61	50	68	2	212
Parking	0	18	20	25		63
Water Surface	0	410	85	--	--	495

d. Prospective supply. Prospective supply is composed of those additional recreational facilities that are anticipated to be constructed after 1980 by respective levels of government and the private sector. This supply differs from programmed supply in that no specific plans have been developed and no programs for funding have been established. However, even though no pro-

grams have been developed, we must anticipate that the various governmental entities and the private sector will continue the construction of recreational facilities beyond the year of 1980. Therefore, prospective supply was developed by projecting the programmed supply developed for each activity between 1960 and 1980 to the year 2020 on a straight line basis. It is shown in Plates 16 through 22.

12. NEEDS. Need is defined as the difference between the existing recreation supply and the total demand. The 1960 need was derived by subtracting the existing 1965 supply from the total 1960 demand. Projected activity needs were determined by subtracting the 1965 supply and the programmed supply from projected demands. Plate 15 illustrates the acute need for more camping and beach space in the Grand River Basin.

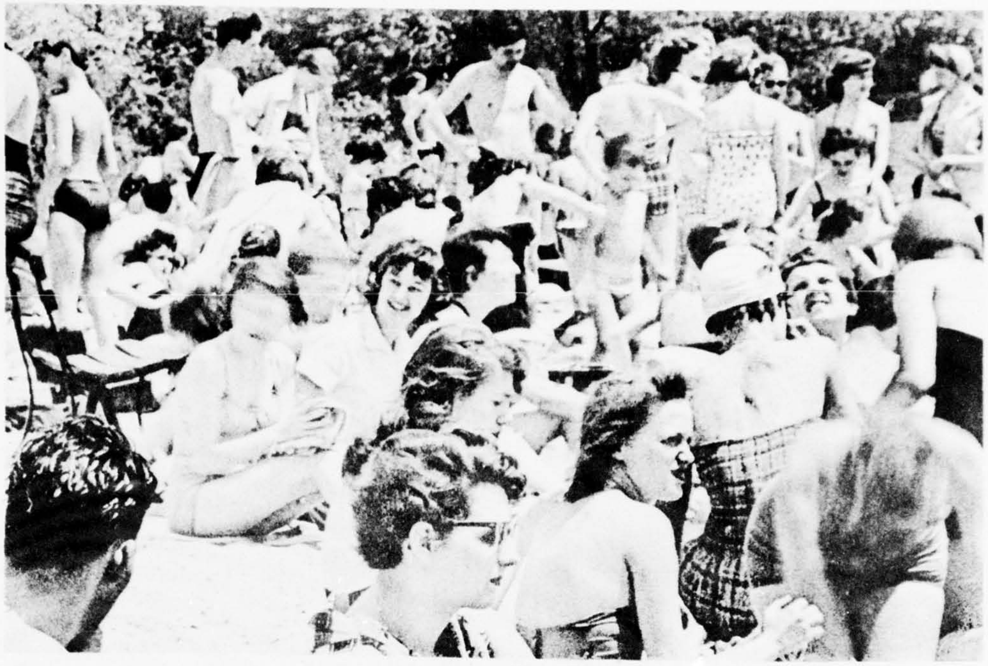
The needs for sightseeing, nature walks, and hiking were computed by applying a percentage figure for each of these activities to the sum of the annual visits for the five activities projected in detail.

The percentage used for sightseeing, nature walks, and hiking were 60, 18, and 4, respectively. These figures were obtained from the per capita participation rates in ORRRC for 1960.

The study assumes that if the water-oriented needs of the five previously defined activities are provided in a quality setting sufficient land will be available for the associated, less intensive activities, such as hiking and sightseeing. See Table 11 for a basin summary of projected needs. See Tables 33 through 37 in Appendix E for details of projection of needs by subarea. Plates 16 through 22 illustrate graphically the amount of developed land needed for the various activities.

The table for needs in 1980 shows the Jackson Subarea with substantial surpluses in camping and the Grand Rapids Subarea with surpluses in picnicking.

Some doubt is held that the projections of demand and needs reflect an accurate picture of the intensity of pressures exerted in the Jackson Subarea. In other words, there is the probability that the projected demand from the Detroit SMSA for recreational facilities is much greater, proportionately, in this area of rolling relief than it is in the more level areas of the lake plain within the Detroit service area. Similar conditions exist for other SMSA's where substantial portions of their respective service areas lie upon relatively flat lake plain relief. However, no attempt was made to adjust effective population and demand figures for this factor because of its nebulous nature and the difficulty in developing a reliable tool to make reasonably accurate corrections. Therefore, surpluses in the Jackson Subarea could easily be more of a paper nature than an actuality.



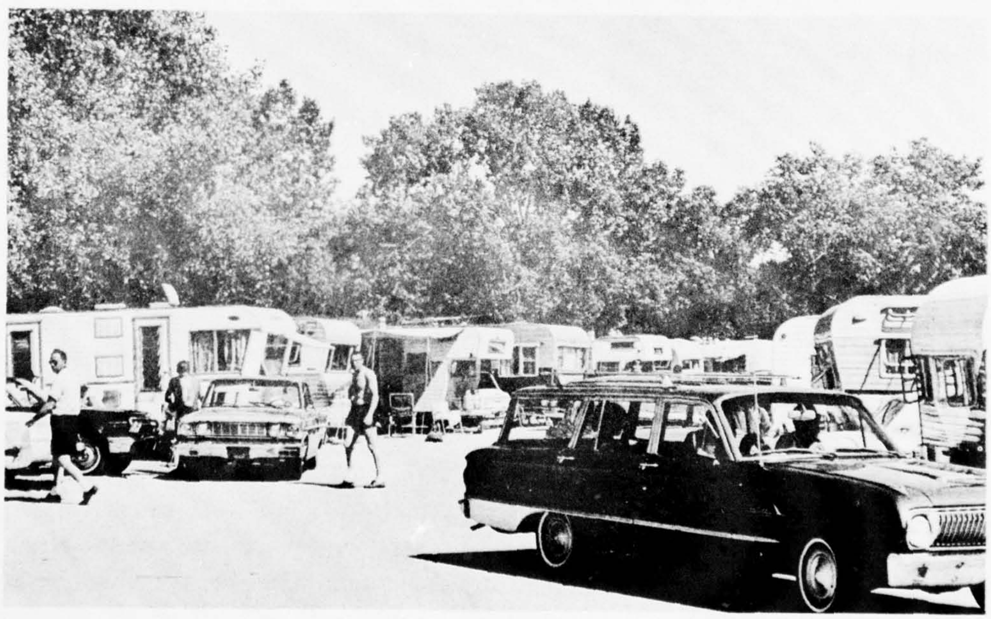


Plate 15--*Overcrowded park facilities result in lower quality experiences, deter many from participating in recreational activities, and cause rapid deterioration of the resource.* (Photo courtesy of Michigan Department of Natural Resources)

Table 11

BASIN SUMMARY OF PROJECTED NEEDS

Activity	Year	Demand in Acres: Developed Land	Demand in Acres: Water Surface (1,000's)	Supply in Acres: Developed Land A*	Supply in Acres: Developed Land B**	Supply in Acres: Water Surface (1,000's) A*	Supply in Acres: Water Surface (1,000's) B**	Need in Acres: Developed Land	Need in Acres: Water Surface
Swimming	1960	98		67				31 ***	
	1980	207			22			118	
	2000	377						288	
	2020	589						500	
Boating and Water Skiing	1960	145	33.8	43		39.0		102	
	1980	327	78.0		17		.5	267	38.5
	2000	610	147.8					550	108.3
	2020	950	232.0					890	192.5
Camping	1960	273		183				90	
	1980	778			146			450	
	2000	1,710						1,381	
	2020	2,919						2,590	
Picnicking	1960	629		460				169	
	1980	1,159			212			487	
	2000	1,919						1,247	
	2020	2,891						2,218	
Parking	1960	264		145				119 ****	
	1980	544			63			336	
	2000	964						756	
	2020	1,493						1,286	
Summary of above Activities	1960	1,409	33.8	898				511*****	
	1980	3,015	78.0		460			1,658	38.5
	2000	5,580	147.8					4,222	108.3
	2020	8,842	232.0					7,484	192.5

* Existing developed land; ** Land programmed for development before 1980.

*** The area of water surface projected to satisfy needs for boating and water skiing will provide the small amount of water surface needed for swimming.

**** Land for parking includes that needed for all parking except boating, water skiing and camping which is included in land needed for the activity.

***** Total needs cannot be accurately obtained by subtracting total supply from total demand because surpluses of facilities in one activity cannot be used to offset a need in another.

PROJECTED NEED FOR DEVELOPED LAND
FOR SWIMMING FACILITIES

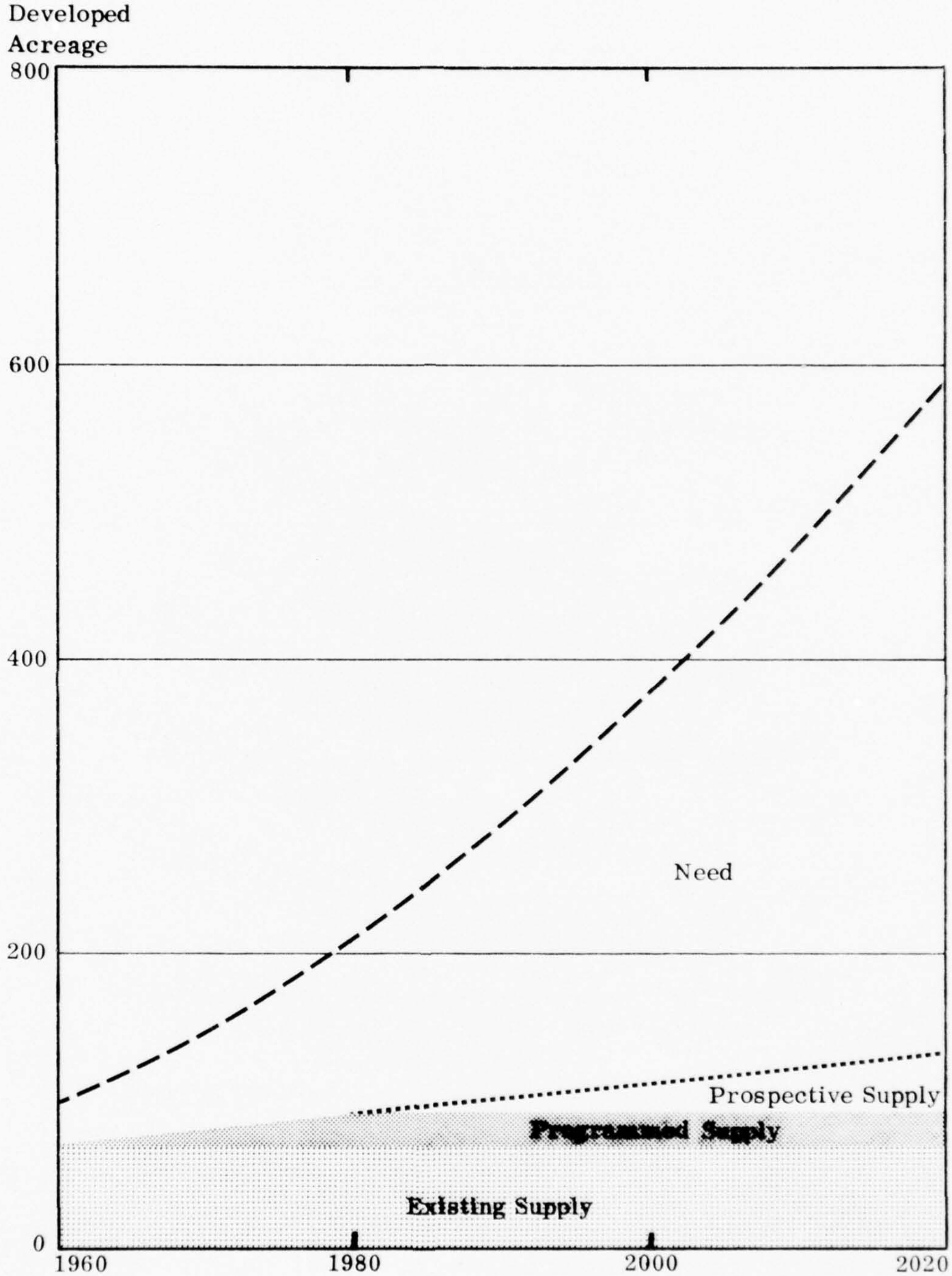


Plate 16

PROJECTED NEED FOR DEVELOPED LAND FOR BOATING AND WATER SKIING FACILITIES

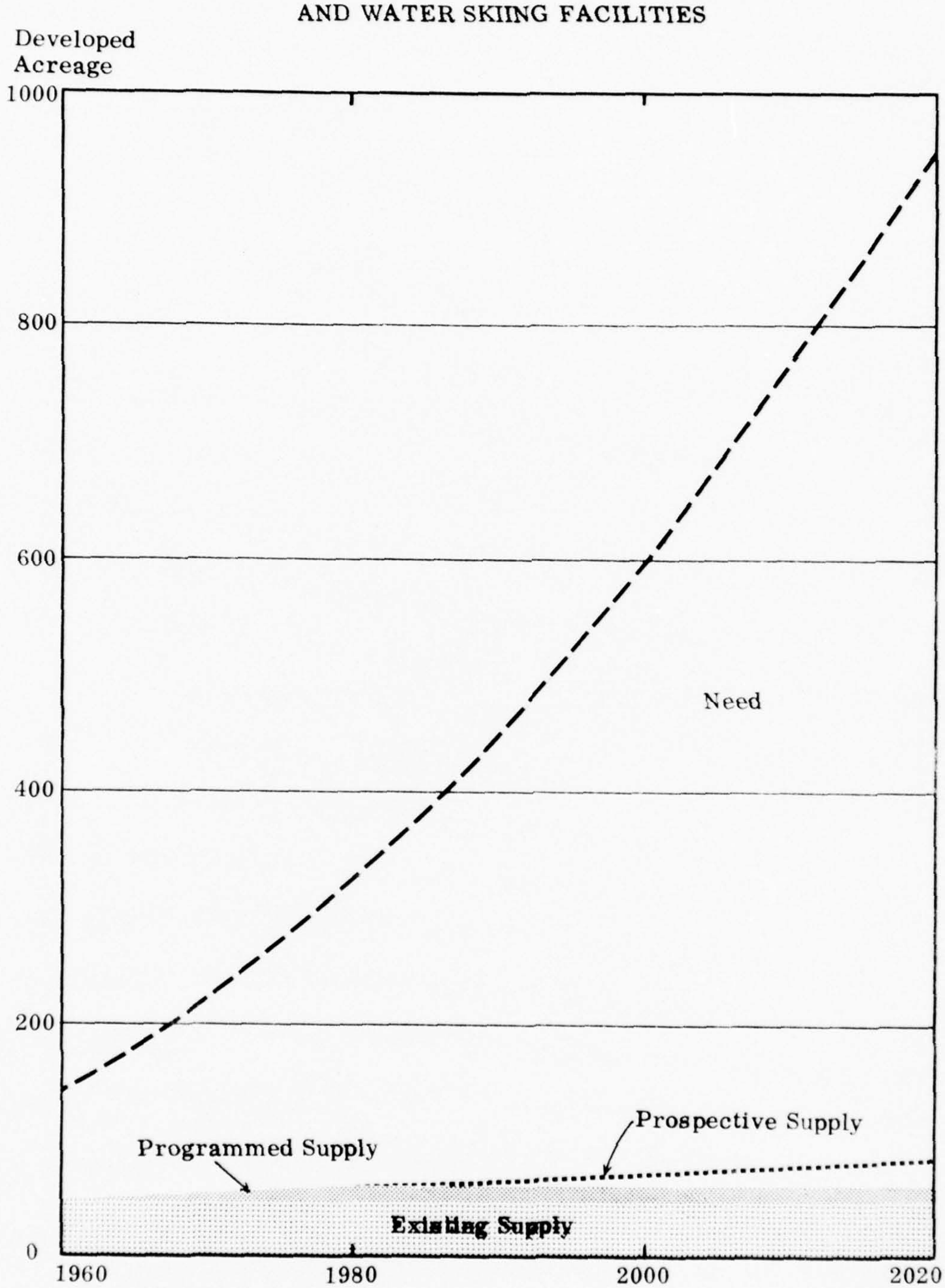


Plate 17

PROJECTED NEED FOR DEVELOPED LAND FOR CAMPING FACILITIES

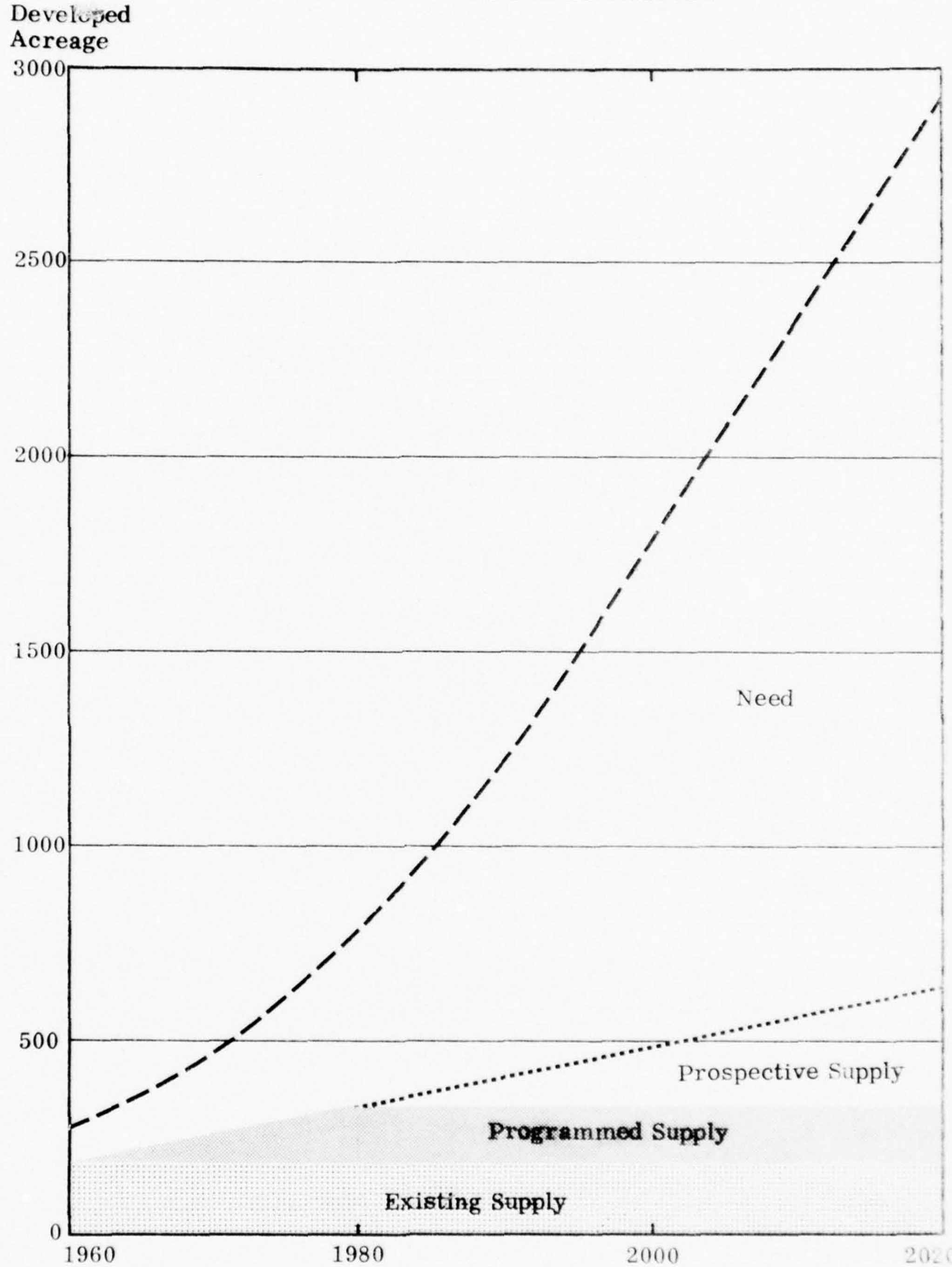


Plate 18

PROJECTED NEED FOR DEVELOPED LAND
FOR PICNICKING FACILITIES

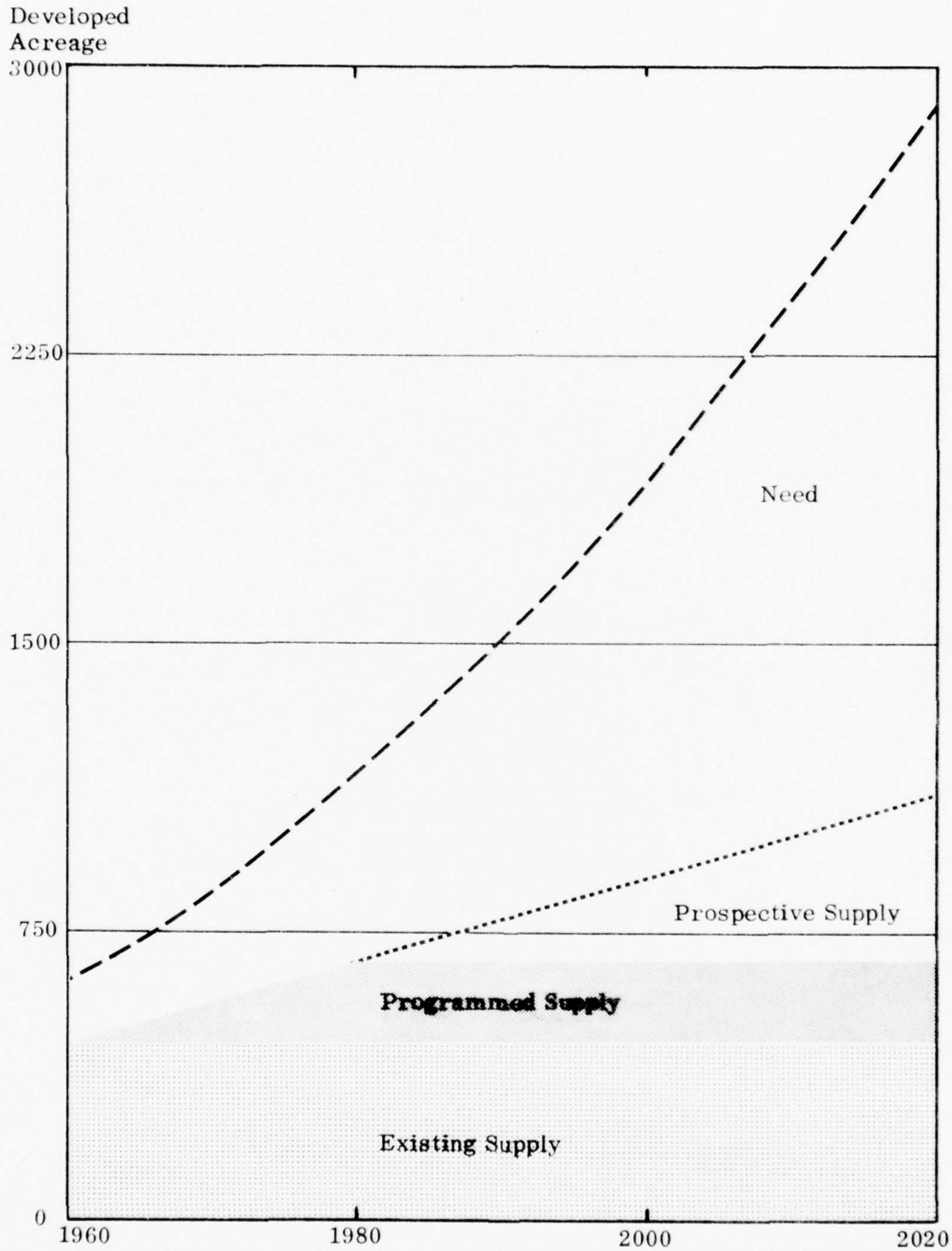


Plate 19

PROJECTED NEED FOR DEVELOPED LAND
FOR PARKING

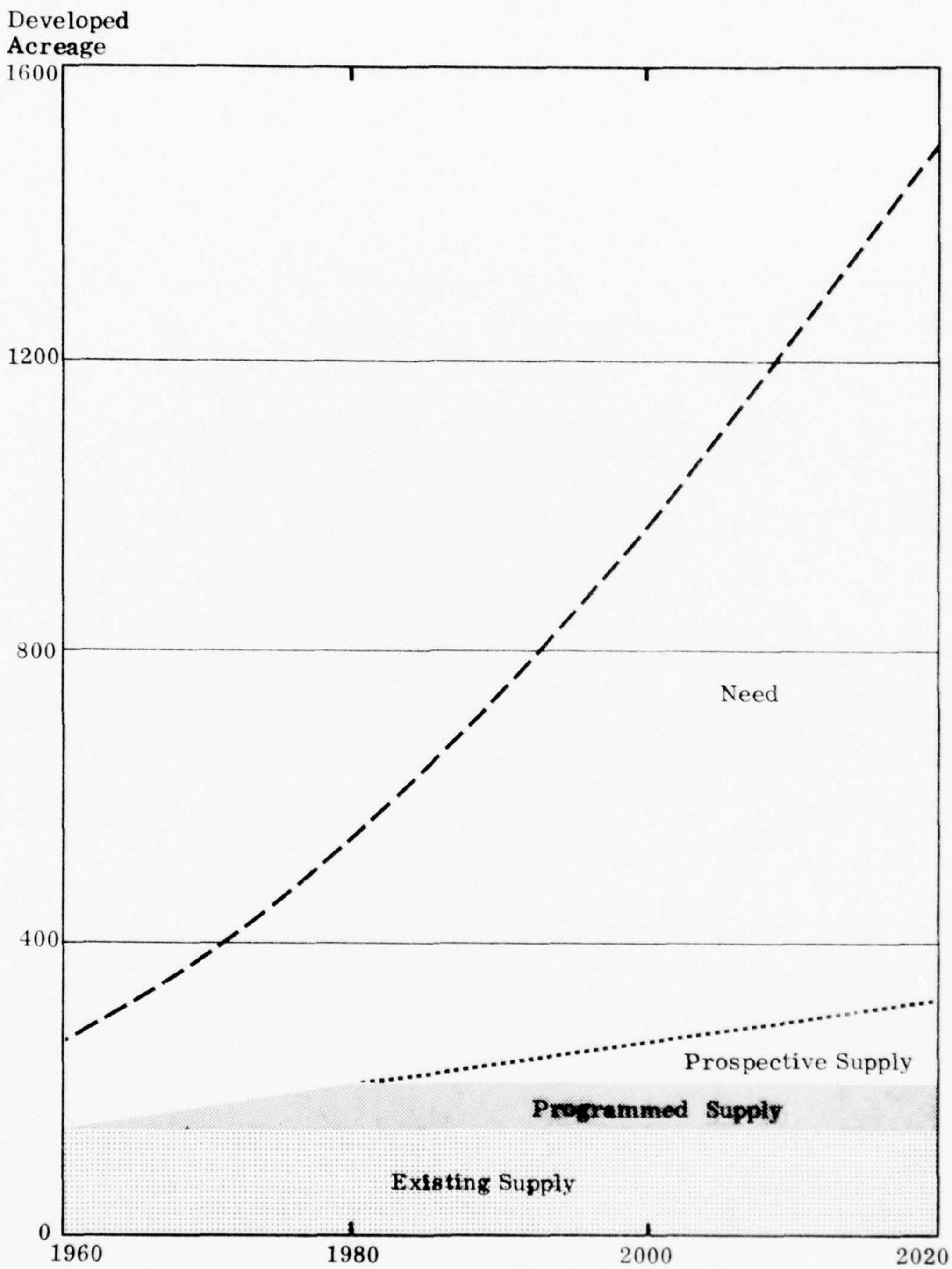


Plate 20

PROJECTED NEED FOR ACREAGE OF WATER SURFACE
FOR WATER-DEPENDENT ACTIVITIES

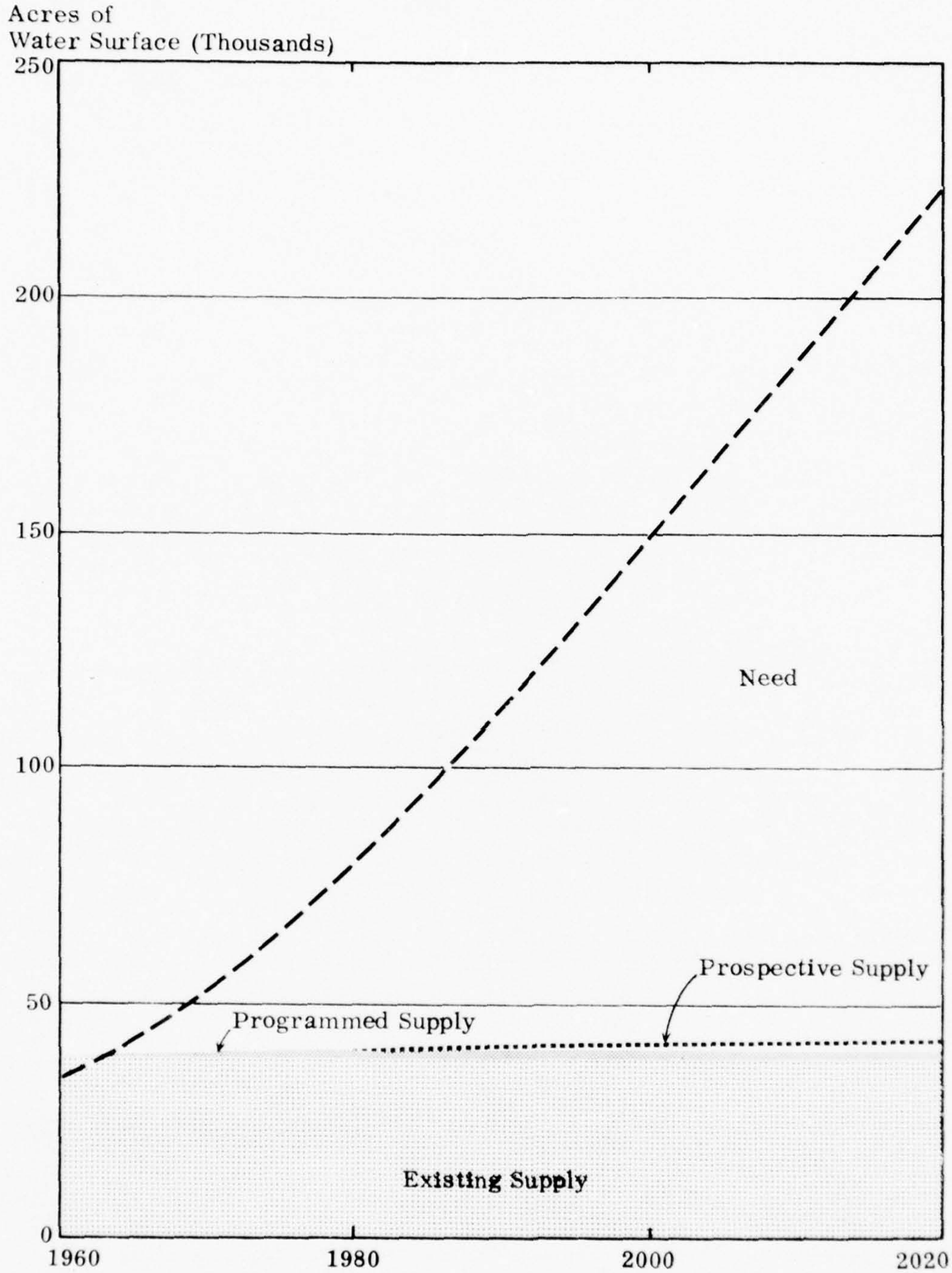


Plate 21

PROJECTED NEED FOR DEVELOPED LAND
FOR THE FIVE MAJOR ACTIVITIES

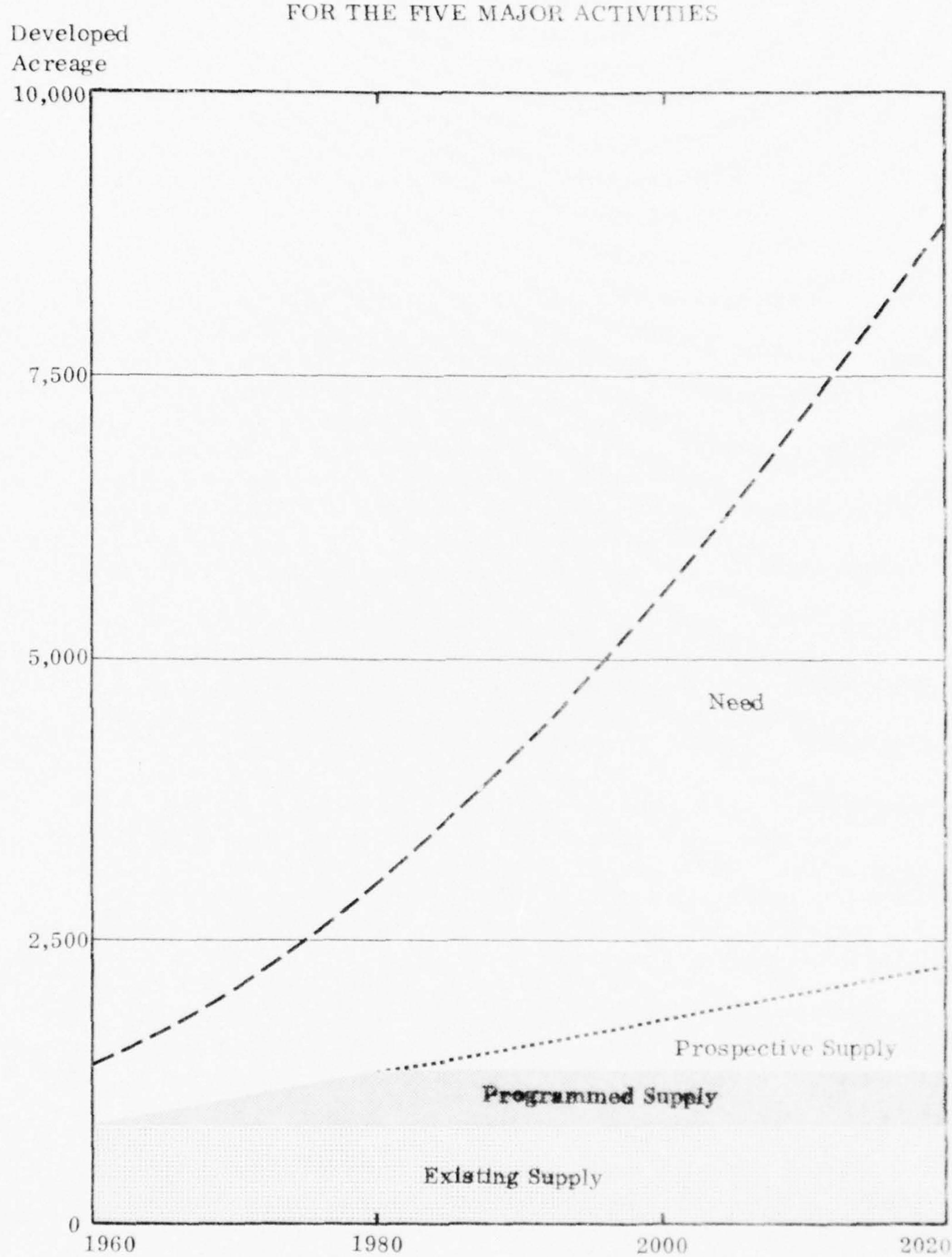


Plate 22

Surpluses in the Grand Rapids Subarea result from the presence of extensive recreational facilities in or near the area and proposed development of substantial additional facilities over the next few years.

The presence of surpluses in certain subareas affects the needs picture for the basin as a whole. When needs are computed for the basin as a whole, surpluses in one subarea reduce existing needs in other subareas. Thus, a true picture of needs for the entire basin is somewhat distorted. Therefore, the sum of the needs for the five subareas may be greater than the stated needs for the basin as a whole.

There may be a surplus of recreational facilities for certain activities in some subareas when a major reservoir is constructed. However, when reservoirs are built to provide needed water surface, it will be necessary to construct recreational facilities on lands adjacent to such water impoundments even though this construction creates a surplus or increases an existing surplus. Such construction will permit the development of a complete recreational facility adjacent to large bodies of water. In most cases, these surpluses will be of a temporary nature and will be absorbed by an increasing demand within a few years. Most of these surpluses will probably be evident at relatively small areas that do not provide an opportunity for a variety of recreational experiences.

The trend toward urbanization has been in progress for many years. This trend is creating large population centers, and provision of sufficient outdoor recreation facilities in close proximity to the people will be difficult, if not impossible.

The research done by Mueller and Gurin indicated the need for several different types of camping facilities. They found that some campers prefer that type of facility which provided quiet and solitude. Others prefer facilities located in such manner as to provide opportunity for socialization with other people. Thus, campgrounds should be located and designed to meet the ranges of needs of all campers.

Mueller and Gurin pointed out that a large majority of American adults do not go camping, but those who do camp are also very active in participating in other outdoor recreational activities, such as swimming, boating, picnicking, and hiking.

Fishing and hunting are two major recreational activities in which many people participate. While it was not a purpose to calculate demand and needs for these activities in this report, needs for fishing and hunting opportunities from Appendix K, Fish and Wildlife, are stated here to provide a more complete picture of the total needs for recreational development. Table 12 presents needs in angler days and hunter days.

Table 12

NEEDS FOR FISHING AND HUNTING
IN ANGLER AND HUNTER DAYS

(In Thousands)

Fishing Needs

Subarea	1980	2000	2020
Jackson	148.6	315.7	497.2
Lansing	192.5	306.5	438.2
West Central	36.3	219.2	427.3
Grand Rapids	84.9	236.3	373.3
Northeast	21.0	52.7	88.5
Basin	483.3	1,130.4	1,824.5

Hunting Needs

Subarea	1980	2000	2020
Jackson	----	58.7	126.4
Lansing	----	145.0	327.9
West Central	----	70.0	154.1
Grand Rapids	----	117.7	281.1
Northeast	----	52.8	118.3
Basin	----	444.0	1,007.8

SECTION IV

OUTDOOR RECREATION PLAN

Water must be recognized as the main attraction for present and future outdoor recreation demand in the Grand River Basin. This history of water abundance in Michigan has set the recreation theme for the State and its people, as reflected by the State adage -- "Water Wonderland."

As the population and its desire to participate in outdoor recreation increases, the lack of available water resources becomes more apparent and of greater concern. The Grand River Basin has been and is being directly confronted with this problem. During the single registration period of 1963 - 1965, nearly 70,000 powerboats were registered by the Coast Guard in the eleven counties of the basin. The problem of overcrowding and turning away of visitors frequently occurs in State parks. The deterioration of water quality has taken its toll of the usefulness of water resources. However, a concerted effort by the State to solve the pollution problem could eventually reverse this present trend and ultimately result in improvement in water quality.

13. APPRAISAL OF RECREATION POTENTIALS. In this study the existing and programmed facilities, the potential of the resources in the basin, and capabilities of programs of agencies are considered.

a. Capacity of Existing Resources. A number of State parks and recreation areas are located in close proximity to the boundary of the Grand River Basin, but only three are located within its borders. There are also a number of county parks in the Grand Rapids area and around Jackson. In many places these facilities are being heavily taxed to meet the needs of the public. The Lansing and Northeast Subareas are especially short of an adequate supply of facilities.

(1) State Parks. There are six State parks and recreation areas in the eleven counties in the Basin study. They provide a wide range of recreation opportunities. Each of these parks is examined here for its present state of development and potentials for additional development.

The Waterloo Recreation Area which lies astride the Basin boundary in eastern Jackson and western Washtenaw Counties and contains about 15,600 acres, has been developed extensively for general recreation and hunting use. This area has space for the development of substantial amounts of additional camping, picnicking, swimming, and other activities. The State reports that new master plans are in the making, which will take into account the circumstance that it will very likely be impracticable to acquire many of the interspersed private land ownerships. On the limited number of sites where suitable land

and water frontage are available, intensive development can be established, with retention of a desirable ratio of related open space and extensive recreation land. The Michigan Outdoor Recreation Plan proposes additions for camping, swimming, parking, and related facilities, also the acquisition of additional land.

The Yankee Springs Recreation Area is located on Gun Lake in western Barry County and contains 4,280 acres of which about 350 acres are water surface. This area provides opportunities for all general recreation activities including swimming, boating, camping, picnicking, fishing, hunting, etc.

The area has the potential for some additional development, especially for land-oriented activities. The Michigan Outdoor Recreation Plan proposes additional parking and camping facilities as well as the purchase of additional land for new parking areas which will permit better utilization of existing swimming beaches.

Holland and Grand Haven State Parks are located on Lake Michigan shores near cities by the same names. Both of these parks contain less than 50 acres each and are very intensively developed for swimming, camping, picnicking, and fishing. These parks are heavily used and provide only limited opportunity for additional development without the purchase of more land.

However, the Michigan Outdoor Recreation Plan proposes the development of a small amount of additional camping and beach facilities at Holland State Park. It also proposes the acquisition of additional land at the Holland Park, but this park can be expanded only to a small extent. Also, because of extremely crowded conditions, the State is planning to remove all camping from the Grand Haven State Park.

The approximately 1,200-acre Hoffmaster State Park is located four miles north of Grand Haven and is relatively undeveloped. A full range of recreation facilities is proposed for development in this park in the Michigan Outdoor Recreation Plan.

The new Sleepy Hollow State Park in Clinton County, near Lansing, will contain a lake of about 400 acres. A full range of recreation facilities is being planned for this park, which will help to serve an area that is now greatly deficient in opportunities for recreation.

(2) Local Parks. Local parks include those recreation facilities provided by county, city, and township governmental units. They provide a very significant part of the local recreational opportunities, especially for swimming and picnicking. Jackson and Kent Counties and the cities of Jackson, Lansing, and Grand Rapids have provided most of the local facilities in

this basin. Many of them provide access to water in lakes and streams. Most of these parks are developed relatively intensively; however, a number of them could accommodate additional picnicking facilities and several of the larger ones have sufficient space for camping facilities.

(3) Lakes. Inland lakes and Lake Michigan beaches form the base for the existing supply of water surface available for public use. Public access on 107 lakes larger than 40 acres in size and 12 lakes between 20 and 40 acres in size provide more than 24,000 acres of water surface for public use. These lakes are used heavily on summer weekends and holidays, but use during the week is much lighter. According to the State of Michigan, most of these lakes have very little potential for the development of additional recreational facilities. However, those lakes that do have significant potential should be developed to their maximum capacity. If additional acreages of land along the shorelines of these lakes were acquired, they could provide increased opportunities for swimming, fishing, camping, picnicking, and other water-oriented activities. The application of time zoning and other management techniques could increase opportunities for boating. See Table 13 for a summary of lakes with public access.

TABLE 13

Water-Surface Area in Lakes

With Public Access

Subarea	Lakes of 40 acres in size		Lakes between 20 and 40 acres in size	
	No. of Lakes	Total Acres	No. of Lakes	Total acres
Jackson	28	5,906	1	34
Lansing	3	718	1	27
West Central	56	12,038	4	121
Grand Rapids	20	5,627	6	153
Northeast	0	0	0	0
Total	107	24,289	12	335

A number of existing natural lakes more than 40 acres in size and not now included in the existing supply because of lack of public access have substantial potential for recreational development. These lakes range up to more than 500 acres in size. The total area of water surface in the 149 lakes larger than 40 acres without public access is more than 17,000 acres. These lakes are concentrated chiefly in the Jackson, West Central, and Grand Rapids Subareas. The shorelines of most of these lakes are heavily developed with

private cottages and residences, and they are used intensively by the owners and their friends. While many of them may not be suitable for development for public use, those that are suitable should represent a significant quantity of water surface that could be utilized to the extent of its capacity. If a sufficient acreage of access land can be acquired on lakes with developable potential, these lands, together with the water surface, have the capacity to provide significant opportunities for boating, water skiing, fishing, and related activities.

There are 161 lakes ranging from 20 to 40 acres in size and comprising a total of about 4,400 acres in the 11 counties in the basin. Practically all of these lakes are in private ownership, and the shores of many of them have been heavily developed with summer and permanent type residences. They were not included in potential supply because the cost of acquiring public access would be very high per unit area of water surface. However, in some instances, these small lakes can provide limited potential for the development of swimming, picnicking, camping, boating with small motors, and related facilities for local use.

Most of these lakes are now used by the abuting property owners and they provide recreational opportunities to those who have access to them. Most of this activity is limited to boating and fishing. Much of the shorelines on many of these lakes has been developed with summer or permanent type residences, thus, acquisition of sizeable tracts of land for recreational development would be difficult. The State of Michigan is continuing to provide public access on some of these lakes as funds become available. See Table 14 for summary of lakes without public access.

Table 14

Water-Surface Area in Lakes

Without Public Access

Subarea	Lakes over 40 acres in size		Lakes between 20 and 40 acres in size	
	No. of Lakes	Total Acres	No. of Lakes	Total Acres
Jackson	24	3,088	29	783
Lansing	12	1,675	14	386
West Central	51	5,680	69	1,920
Grand Rapids	50	5,771	37	986
Northeast	12	1,185	12	267
Total	149	. 17,399	161	4,332

Lake Michigan represents a vast expanse of water surface with potential for recreational use, but certain factors limit its capacity for that use. The water surface is commonly rough and does not provide an ideal situation for the operation of small boats either for boating or for water skiing. According to the Michigan Department of Natural Resources, small boats can operate on Lake Michigan only about one day out of four.

The shoreline has mile after mile of excellent sand beaches which, where there is public access, are used intensively when weather conditions are favorable. Lake Michigan beaches are closed about one day out of three during the summer recreation season because of undertow. Northwesterly to northerly winds bring cold waters southward along the Michigan shore on many other days during the summer which limits actual swimming. However, many people sunbathe on the beaches when swimming conditions are unfavorable.

(4) Rivers. The major streams and related lands comprise a notable resource which is worthy of consideration in a study where consideration must be given to the potential of all available resources. In some specific instances, optimum development could be directed toward the preservation of the natural beauty of the stream and its surrounding landscape.

The Grand River between Lake Michigan and Lansing, is about 150 river miles in length; about 110 miles of this total lie between Grand Rapids and Lansing. The width of the stream varies from 800 feet in its lower reaches to about 100 feet near Lansing. The floodplain ranges from one-quarter to three-quarters of a mile in width. In most places between Grand Rapids and Lansing, the valley walls rise 100 feet or more above the floodplain and proffer a variety of scenic views.

The river channel above Grand Rapids normally flows from 100 to nearly 500 feet in width, but in many places the depth of flow is relatively shallow. Assuming an average width of 200 feet, this segment of the river has 24 acres of surface water per mile of length or approximately 2,600 acres of water surface between Lansing and Grand Rapids. Assuming an average width of 500 feet below Grand Rapids, the surface area of the river would amount to about 60 acres per mile of length or a total surface area of about 2,400 acres between Grand Rapids and Grand Haven. Thus, nearly 5,000 acres of water surface are available for use on the Grand River alone. With the installation of necessary sewage treatment facilities at Jackson, Lansing, Grand Rapids, and several of the smaller communities, these waters could be of relatively high quality and could be very attractive for recreation use. However, fluctuations in stream flow, which is usually low in late summer and fall, could substantially limit this potential. On the other hand, supplementation of stream flow through the use of stored water for low-flow augmentation could stabilize flows and benefit the recreation potential.

Other major streams that have substantial potential for the development of recreation opportunities include the Rogue, Thornapple, Flat, Lookingglass, and Red Cedar Rivers. No attempt was made to estimate the surface water areas in the usable portions of these streams.

Inadequate access on all of these streams limits use by the public. These streams and their related floodplains could supply substantial additional opportunities for the development of all types of recreational activities, especially picnicking, camping, boating, fishing, hiking, nature walks, etc. They could be especially effective in providing space for recreational development in and near urban areas. The State of Michigan is continuing to provide additional public access sites as funds permit. The development of these resources, unless they have greater value as natural areas, could provide interesting new opportunities for outdoor recreation along free-flowing waters.

(5) Private Development. At the present time, the private sector provides a very significant amount of opportunities for camping and hunting together with a small amount for swimming, boating, fishing, picnicking, and miscellaneous activities. The private sector could provide an additional substantial amount of recreational opportunities in camping and picnicking. Where a landowner has access on a suitable lake, he could provide opportunities for swimming, boating, and fishing also. However, many people do not want to own or manage swimming beaches because of the problem of providing adequate protection to swimmers and the high cost of liability insurance. The cost of developing a recreation facility with varied opportunities is quite high, and this factor eliminates most land owners from entering the recreation field. Every effort to encourage the development of recreational opportunities by the private sector should be explored, and obstacles should be removed wherever it is feasible to do so.

(6) Other Potentials. Since the area to the north of this basin has much lower concentrations of population and lies somewhat farther removed from large metropolitan areas, resources to the north could be developed to accommodate a portion of that demand derived from overnight or weekend use and allocated to the Grand River Basin. There are substantial amounts of resources to the north of this basin that have significant potential to accommodate swimming, camping, picnicking, and other related water-oriented activities.

b. Capacity of Potential Development. New facilities to satisfy the ever-increasing demand for recreational opportunities can be constructed around several types of water resource development. These include new parks on existing lakes or on new impoundments constructed by local or State

interests, new recreation areas on the floodplains of major streams, and new recreation areas on Corps of Engineers and Soil Conservation Service multipurpose reservoirs.

(1) State Parks. The State of Michigan is developing a new State park, Sleepy Hollow, on an impoundment of about 400 acres in Clinton County in the Lansing Subarea. This park will provide a full range of recreation opportunities on an area of about 2,700 acres of land. It will service the day-use needs of the Lansing area and the overnight and weekend needs of recreationists within 125 miles of it. The initially planned facilities are included in programmed supply. However, this park will have the capacity for the development of substantial additional recreational facilities to help satisfy future needs.

Another small reservoir, Bear Creek or Soil Conservation Service site 109, is proposed for construction in western Shiawasee County about five miles east of Sleepy Hollow State Park. This site is included in the work plan for the Upper Maple River Watershed Program and would contain about 280 acres of water surface. It is proposed to be developed for camping, fishing, boating, picnicking, and other similar activities.

The planned Ionia Recreation Area, located on the Grand River in Ionia County in the West Central Subarea, will contain about 3,700 acres including a water surface of about 85 acres. This area has about four miles of frontage on the south bank of the Grand River just west of the City of Ionia. A full range of day-use, weekend, and winter sports facilities is being planned for this area. It will service the Grand Rapids and Lansing Subareas and other areas to the north. While most of the planned facilities were included in programmed supply, this area can support extensive additional development.

The proposed Newaygo State Park will be located on the Hardee Dam Reservoir on the Muskegon River in Newaygo County. This park will lie just outside of the Grand River Basin, but it will provide substantial opportunities for people living within the basin, especially the Grand Rapids Subarea. This park will contain about 900 acres of land. It will be developed primarily for camping, fishing, boating, and closely related activities.

The new Hoffmaster State Park is located on Lake Michigan in Muskegon County near the Ottowa County line. This park contains about 1,200 acres of land and will provide a variety of recreational activities. However, it will not provide facilities for boating and water skiing because of adverse conditions on Lake Michigan. This park will need to be managed with care since much of its landscape consists of steep, very fragile lake-front dunes. Facilities will need to be planned to route pedestrian traffic over those areas not susceptible to severe damage. This park will provide recreational opportunities for people primarily from the Grand Rapids and West Central

Subareas and other nearby areas. The initially planned facilities are included in programmed supply. However, this area can provide space for moderately large quantities of additional recreational facilities.

(2) Valley Preserves. The floodplains and related lands along the major streams in this basin provide an excellent base for the development of recreational opportunities. These lands have been plagued by recurring floods down through the years as man has sought to utilize them to his advantage. The development of such lands for recreational uses can be compatible with their retention as floodways during periods of high water flows.

Most cities of any size in this basin are located on the floodplains of major streams. Therefore, the development of floodplains and closely related lands as major recreational complexes could place recreational opportunities closer to people in urban areas than any other feasible alternative. Over a period of time, some of these recreation areas could be extended entirely through urban areas adding substantial aesthetic attractiveness to the urban center as well as providing recreational opportunities.

As the needs increase in the years to come, these valley preserves could be extended upstream and downstream from urban areas to eventually coalesce into a continuous system of recreation complexes along the major streams. These areas should encompass all of the floodplains and as much of the adjacent lands as would be needed to provide a manageable and serviceable recreation unit or units. Certainly, they should include much of the steep, sloping lands adjacent to the floodplains to protect them from incompatible development and to provide lookouts and scenic vistas for the recreationist. Insofar as possible and practical, the boundaries should follow established features such as highways and property lines.

Much of these areas should be acquired in fee simple to provide necessary space for the development of recreational opportunities. In areas where agriculture is a dominant use of the floodplain, either effective zoning measures could be applied or easements could be acquired on such land, thus permitting them to remain in existing uses. Where easements are used, they should contain options to purchase or restrictive covenants prohibiting detrimental uses when adverse changes in use become imminent. Agricultural and other compatible uses would add variety to the landscape for the users.

The valley preserve system could support a rather broad range of recreational activities in a wide range of settings. Swimming could be developed at locations having suitable stream bank slopes, bottom conditions, and water quality. Groins and low head dams could be used to develop such areas. Where swimming cannot be developed directly in the stream, swimming facilities could be developed adjacent to the stream using water from it. The potential for the development of swimming opportunities are many.

Nearly 5,000 acres of water are available for boating and fishing in the Grand River between Lansing and Lake Michigan. In its present state, much of this water would not be usable for large powerboats or water skiers because of insufficient depth. However, the construction of lowhead dams could substantially increase the usability of these waters by boaters and fishermen. Fallen trees, snags, and other debris hazardous to boaters should be removed periodically to permit maximum utilization of the water surface.

Camping and picnicking facilities could be developed on any well drained lands not subject to frequent flooding. Such areas could be developed on suitable areas in the valley or on high lands overlooking the valley to provide a wide variety of opportunities to recreationists. Some lower segments of smaller tributary streams could be used effectively to provide camping areas somewhat removed from the main stream of traffic.

The valley preserve concept is well adapted for the development of a trail system for hiking, nature walking, bicycling, horseback riding, and similar compatible activities. Snowmobiling could be permitted on portions of this trail system during winter months. Such a trail system could be tied into the North Country Trail and other local trail systems.

The acquisition of extensive areas of land along the major streams would provide substantial opportunities for fishing and hunting. Where State game areas lie adjacent to major tributary streams, the valley preserve should be extended to the boundaries of such areas.

Where the valley areas are suitable for such development, scenic highways could ultimately be developed for the public. However, such highways should not be developed at the expense of other higher priority recreationists; they should be installed only where they would be compatible with other recreational activities.

The development of a valley preserve system on the Grand River and its principal tributaries would greatly reduce flood damages in future years by prohibiting the development of such lands for uses subject to flood damage. Proper planning and construction of recreational facilities would keep flood damages to a minimum. This system would provide open space to urban areas by prohibiting new development on floodplains, and over a long period of time, eliminate existing development in such areas.

(3) Evaluation of Sites for Reservoirs. The Corps of Engineers provided a total of 79 sites for study of their recreational potential. A total of 132 sites was received from the Soil Conservation Service for study. The physical quality of each potential site was measured in terms of present land and water features, and the character that each site would assume if it were developed.

Five broad factors were considered to be essential in the rating of proposed reservoir sites for their value for recreation. They include: (1) capacity of the site to satisfy the needs of people; (2) facility development possibilities; (3) variety of recreational opportunities available; (4) size and quality of the pool; and (5) aesthetic qualities.

Facility development possibilities include the potential for the development of quality facilities for a variety of activities in at least one area next to the shore.

The variety of recreational opportunities available includes the potential for the development of an adequate mix of water-dependent and water-enhanced activities in one or more areas. The site should provide good opportunity for boating and swimming.

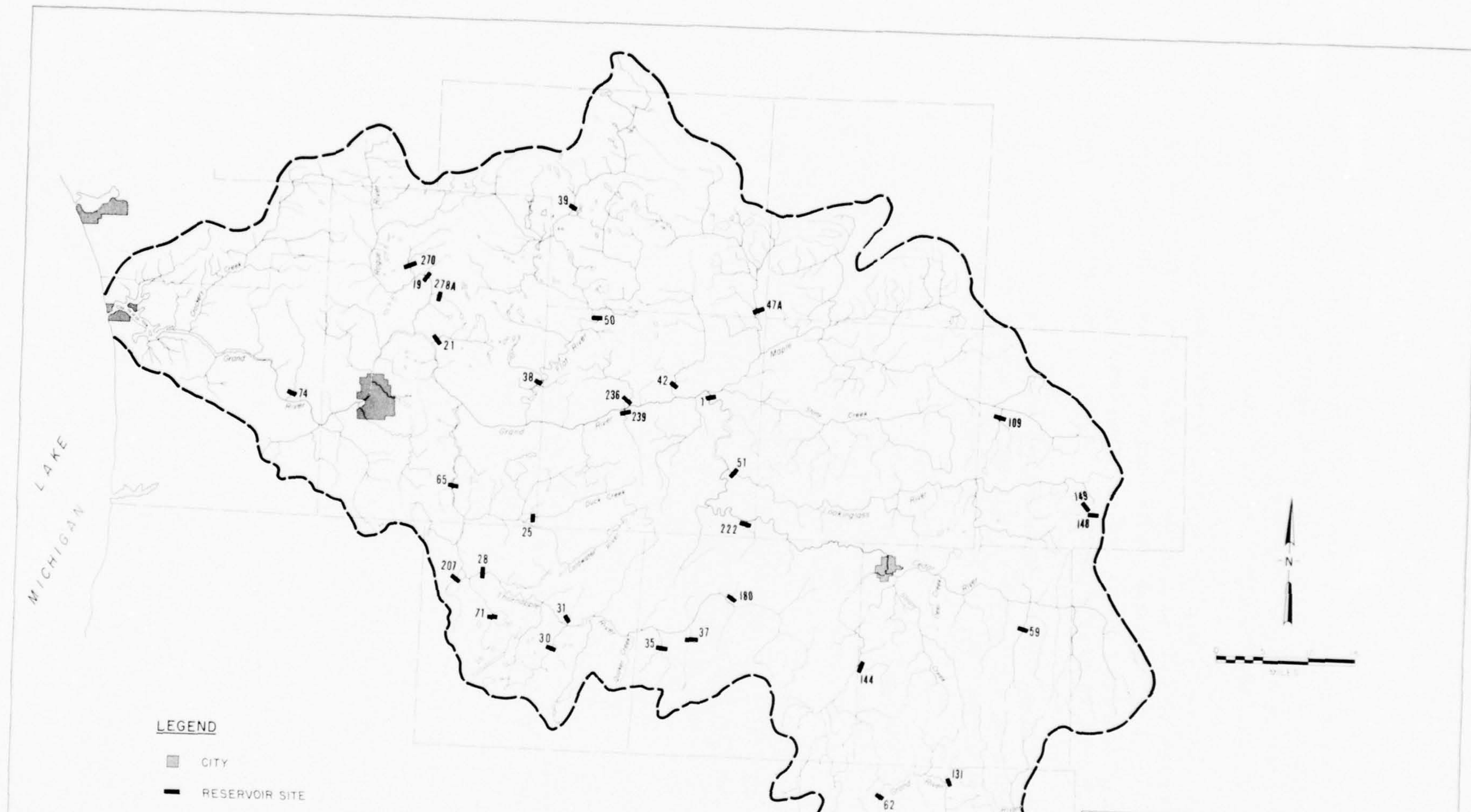
Size and quality of pool refers to the surface area, depth, and drawdown, and quality water during the summer recreation period. Where facilities for powerboating and water skiing are developed, the pool must be of sufficient size and configuration to permit safe engagement in such activities and to provide adequate safety standards to preserve shorelines from erosion by wave action and protect near-shore activities from danger. The pool should have a minimum depth of about 20 feet in the deeper areas, and well over one-half of its total area should have depths of five feet or more. There should be sufficient inflow over evaporation and outflow during the summer to keep drawdown to a maximum of two feet or less. Consideration was given to the nature of bank slopes in areas that might be developed for bathing beaches.

The area around the proposed site should have sufficient relief to produce an aesthetically pleasing setting for recreation. There should be no environmental disturbances, such as junkyards, dumps, quarries, etc., that would detract from a quality recreational setting.

The existence of extensive development of housing, railroads, and major highways can easily raise the cost of development of a reservoir and related recreation areas beyond the point of economic feasibility.

A total of 33 reservoir sites have been identified as having significant recreational potential. They are listed in Table 15 and located on Plate 23. They consist only of those areas where quality recreational facilities can be effectively developed. These sites were selected from those being studied by the Corps of Engineers and the Soil Conservation Service.

Several sites included in this group were listed at less than maximum developable potential because of the long period of time required for them to fill. All sites having a potential storage capacity of more than 20 inches of run off from the drainage area above it were reduced to that capacity equiva-



GRAND RIVER BASIN

RESERVOIR SITES WITH RECREATION POTENTIAL

Plate 23

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
Lake Central Region Ann Arbor, Mich.
March 1967

Table 15

RESERVOIR SITES HAVING GREATEST POTENTIAL FOR RECREATION

Subarea	County	Site	Site Number	Eleva-tion	Water Acres
Jackson	Jackson	Liberty (Coe, SCS)*	10	1,020	510
		Sandstone Creek (COE)	62	950	7,460
		Western Creek (SCS)	131	920	500
Lansing	Eaton	Shanty Brook (COE, SCS)	35	860	570
		Lacey Creek (COE, SCS)	37	860	1,710
		No Name (SCS)	180	875	300
	Ingham	Doan Creek (COE)	59	900	2,700
		Columbia Creek (SCS)	144	890	400
West Central	Barry	Irving (COE)	28	760	550
		Cedar Creek (COE)	30	880	2,540
		No Name (COE)	31	890	430
		Glass Creek No. 2(COE, SCS)	71	840	1,610
		Bassett Creek (SCS)	207	740	300
	Ionia	Lyons (COE)	1	710	3,100
		Duck Creek (COE, SCS)	25	820	940
		Prairie Creek (COE)	42	750	1,820
		Dickerson (COE)	50	800	990
		Portland (COE)	51	760	3,230
		Frayer Creek (SCS)	222	820	190
		Bellamy Creek (SCS)	236	740	350
		Sessions Creek (SCS)	239	720	220
	Montcalm	Upper Flat (COE)	39	850	1,920
		Fish Creek (COE)	47A	750	3,200
Grand Rapids	Kent	Rockford (COE)	19	740	5,400
		Lower Flat (COE)	38	750	2,020
		Alaska (COE)	65	720	2,690
		Cedar Creek (SCS)	270	800	800
		No Name (SCS)	278A	830	500
		Bear Creek (SCS)	21	734	400
	Ottawa	Sand Creek (COE)	74	660	1,470
Northeast	Shiawasee	Bear Creek (SCS)	109	761	280
		Lookingglass River (SCS)	149	870	400
		Grub Creek (SCS)	148	870	530
TOTALS		33 sites			50,030

*COE -- Corps of Engineers
SCS -- Soil Conservation Service

lent to permit the impoundment to fill within three years. It is reasonable to expect that impoundments with longer period of fill time will be subject to excessive water level fluctuation.

Insofar as possible, some of the 33 selected sites were located near urban centers. However, the Lansing and Northeast Subareas are composed of relatively flat land with very few good reservoir sites available. Consequently, even though needs are substantial in these areas, there were only very limited numbers of sites from which to select, and of these, only a very few have significant developable recreation potential.

Many of the smaller sites being studied by the Soil Conservation Service have the capacity to meet a substantial amount of needs for all recreational activities except water skiing and powerboating. See Plate 24. Some of these small reservoirs, if they are developed, should be managed exclusively for canoeing, boats with very limited horsepower, and related land-based activities to provide opportunities for those who enjoy quiet relaxation on or near the water.

Plate 24--*Small lakes can provide pleasant settings for camping, picnicking, swimming, and other activities.* (Photo courtesy of U.S.D.A., Soil Conservation Service)

Several proposed sites in the basin have potential for good recreational development, but they were not included in the above group. Two of these sites, Alder Creek and Millet, have been preempted by residential development and their acquisition would be costly. They lie in the Lansing Subarea, an area of great need. The Highbanks site, lying on the West Central Subarea and having significant recreational potential, could be developed with about 1,500 acres of surface water. However, this site has some high quality suburban development under construction in the vicinity of Bristol and Long Lakes which would be inundated if the site were developed. The lower Coldwater site has excellent potential for an impoundment and recreational development. However, the Coldwater River, one of the few streams with considerable aesthetic qualities remaining in the basin, flows through this valley. It is believed that this stream should be preserved in its natural state for its aesthetic qualities.

Other proposed sites in this basin would have some potential for recreational development, but they have been ruled out for various reasons such as: (1) impoundments with considerable shallow water, (2) sites with much flat land with limited recreational potential adjacent to them, (3) sites with very steep side slopes, and (4) sites that have been preempted for other uses.

With the rapid rise in unsatisfied demands and with at least ten years of lead time required for the planning and construction of a facility, it is extremely doubtful that the needs can be satisfied within the basin by the year 1980.

By the year 2020, the projected demand for surface water for boating and water skiing is estimated to be 232,000 gross acres. This acreage is more than six percent of the total area of the watershed. The existing supply of 39,000 acres of surface water and the programmed development of 500 acres will leave an unsatisfied demand for the development of nearly 200,000 acres of surface water by the year 2020. Needs for swimming and land-based activities can be satisfied on limited areas of water surface.

There may be some potential for canoeing and boating on rivers downstream from flood control reservoirs as excess water is released from these impoundments in the fall of the year in preparation for the storage of flood flows during the winter and spring months. If such waters are released in a manner to provide substantial stream flows on weekends in the fall, it is believed that boaters and canoeists can derive significant benefits from such releases.

(4) Evaluation of Land for Recreation. Criteria for evaluating the character of land for recreational use adjacent to potential reservoirs included the amount and location of existing forest cover; suitability of relief and soils for recreational development and use; and the present extent of development, including such factors as railroads, subdivisions, and major highways. The presence of trees add immeasurably to the quality of a recreation site. Their shade and aesthetic qualities, as illustrated in Plate 25, are almost a neces-

Plate 25--*Native hardwoods and pines enhance the aesthetic qualities of these recreation areas.* (Top photo courtesy of Michigan Tourist Council; Bottom photo courtesy of Michigan Department of Natural Resources)

sity for picnicking, camping, sightseeing, hiking, etc. In some proposed reservoir sites, practically all existing forest cover is located in the flood plain and would be destroyed if a reservoir were built. With no forest cover, the potential for recreation would be severely limited on such sites until such cover could be restored.

The relief should have sufficient slope to add character to the site. Flat, nearly level land over large areas can be monotonous and often limits the opportunity for the development of quality recreation areas. However, where tracts of nearby level land are interspersed among areas of rolling relief, they can be used very effectively for the development of recreational facilities. There should be a sufficient extent of land that is not too steep to permit the efficient development of intensive use areas.

The character of soils plays a vital role in the efficient development of quality recreation areas. Wet, impermeable soils dry slowly after rains and do not provide a good base for the development of intensive use areas. Drouthy soils do not support a vigorous growth of vegetation, and intensive use soon destroys the necessary ground cover and causes destructive erosion. The range of characteristics among soils in this basin is quite broad, varying from very sandy soils to soils with relatively high contents of clay.

c. Capability of Present Program. According to the Outdoor Recreation Plan for the State of Michigan, the State plans for the development of about 500 acres of water surface by 1972. Approximately 400 acres of this amount will be located in Sleepy Hollow State Park and 85 acres will be in the Ionia Recreation Area. At this rate of development, the supply of water surface in 1980 will fall short of demand for it by nearly 40,000 acres. The plan indicates that the State is considering an accelerated program of lake development, but it seems unlikely that the State can begin to meet the growing demand with only its own efforts. It is believed that the State cannot and will not meet the need for land-based and water-based facilities. Therefore, both existing and new facilities will be used beyond their capacity and will suffer deterioration as a result of such heavy use.

According to the State Recreation Plan, the program of many local units of government will be dependent on assistance from the State and Federal Governments for development. However, there will continue to be a heavy demand on the resources of local governments.

14. ESTABLISHMENT OF GOALS. The establishment of a set of goals pertaining to recreation is essential before a plan is formulated for any project. Goals provide an objective or objectives to be attained by following the plan of action. The goals that seem to be most important to the citizens of this basin include: (1) an adequate supply of surface water to provide boaters, water skiers, swimmers, and other recreationists sufficient water for their reasonable needs; (2) an adequate provision of on-shore facilities; (3) water of such

quality that full body contact can be made without personal risk; (4) stability of water levels in such manner as to create high quality recreational experiences during the summer season; (5) the development of recreational facilities in such a manner that recreationists receive a quality experience; (6) the location of the necessary facilities within reasonable travel time from those who use them; and, (7) coordination of recreation programs with other related land and water uses.

15. ALTERNATIVES. Several alternatives were available for consideration in the development of a recreation plan for this Basin. They included: (1) continued expansion of existing State and local parks, (2) development of new parks on existing lakes, (3) development of new parks on new impoundments, (4) development of new parks on Lake Michigan, (5) development of recreation areas along major streams,(6) development of facilities by the private sector; and, (7) transfer of needs to areas outside of the basin.

Some of the existing State parks have little or no room for expansion on existing land holdings. Acquisition of additional land would be very expensive, especially where it consists of lake frontage and nearby property. On most lakes, the desirable frontages have been platted and developed for cottages and permanent residences. Other State parks do have expansion room, but their water surface is being utilized to its full extent; thus, development of additional facilities could be accomplished only for land-based activities. Several new State parks have substantial undeveloped space.

Land for new State parks could be acquired and developed on several of the larger existing lakes, but it would require the purchase of many small tracts of residential or cottage property at a very great cost. These lakes are already being used heavily for boating, fishing, and, to some extent, for swimming by abutting and nearby property holders. Thus, new parks developed on existing lakes could provide additional opportunities for land-based activities and swimming, but there appears to be only limited opportunity for the development of additional opportunities for other water-based activities. In any case, acquisition of a sufficient area of land would be very high.

There is substantial opportunity for the development of facilities for all types of recreational activities on new impoundments. Such impoundments and the adjacent land area could be developed without limitations imposed by intensive residential development present on most existing lakes.

The shores of Lake Michigan present problems somewhat similar to those found on existing inland lakes, that is, the shores in many places have been developed intensively for residential use. Thus, the State finds it difficult to acquire large tracts of land on the lakeshores. In addition, while the lake

presents excellent opportunities for swimming, it offers very limited opportunities for boating, water skiing, and fishing from small craft.

The floodplains of the major streams in the basin present an excellent opportunity to extend recreation areas close to urban centers. They also present the potential for the development of a wide variety of activities, although opportunities for boating would be limited to smaller boats. Implementation of the valley preserve concept appears to be the most difficult problem to solve.

The private sector should be encouraged to develop recreational facilities, especially for land-based activities, in areas of substantial need. The private sector cannot be expected to develop water surface for recreational use, except as small impoundments are developed in conjunction with residential development or for pay fishing. However, the private sector could provide opportunities for camping, picnicking, and swimming, and, to a lesser extent, other related land-based activities.

Another set of alternatives need to be considered at this point. The task of attempting to develop water surface to satisfy needs for powerboating and water skiing within the basin by the year of 2020 is economically and almost physically impossible.

Therefore, those individuals who desire to participate in these activities will probably have to: (1) accept much lower standards for space than those used in the development of projected needs in the report, (2) spread their participation in such activities throughout the week, (3) seek opportunities to satisfy their desire for water-dependent activities on facilities located outside of this watershed, and/or (4) seek the satisfaction of their desires in other recreational activities.

The acceptance of lower space standards would increase the potential for bodily injury and conflict with other water-based activities. Existing and planned areas of water surface have the potential to satisfy much greater quantities of need for water-based activities, if such areas are more fully utilized throughout the week rather than just on weekends.

Recreationists will need to satisfy their desires for outdoor activities in some other type of activities. At this time, however, it would be only conjecture to attempt to determine what activities might be used as substitutes. Some of the needs arising from weekend use could be transferred to areas north of the basin. On the average, about 37 percent of total demand in the basin is

derived from weekend use. Many lakes within 125 miles of the basin boundary are already heavily used. However, there are numerous opportunities to develop opportunities for camping, picnicking, and related activities along streams in the State and National forests.

16. PLAN OF DEVELOPMENT. The objective of recreation planning is to provide the public with sufficient usable water and related land-based recreational facilities to reasonably satisfy the public's demand. To be totally complete, a recreation plan should include the proposed development of recreational facilities by all levels of government and the private sector. However, in a plan of the magnitude being developed for the Grand River Basin, it would be very difficult to identify specific developments proposed by individual local units of government. In addition, the private sector will function only in those areas where there is opportunity to make a profit without undue risk. Therefore, the recreation plan set forth in the following pages is limited to those segments that would be developed by the Federal and State Governments and to the certain major segments of development involving local units of government.

Insofar as reasonably possible, reservoirs included in the early action plan were selected for their capacity to satisfy needs in a quality environment. However, in several instances, it will be necessary to transfer needs from one subarea to another or to areas outside of the basin because developable sites within the Lansing and Northeast Subarea are very limited. Thus, small surpluses of facilities for several activities in Jackson and Grand Rapids Subareas can accommodate unmet needs in the other subareas.

The level of development proposed for each of the reservoir sites listed in this section represents an initial level only. Since it is proposed to acquire all land that would be needed for full development when the reservoir is constructed, additional facilities could readily be constructed to meet new needs as they develop in the post - 1985 period.

The level of ultimate development proposed for each of the sites listed in the basin plan ranges from about 10 to 15 percent of the total land area for the eight activities used in this study. The inclusion of additional space to accommodate other activities not considered in this study would require an additional three to five percent of the land area. Thus, total development of space for intensive use would amount to about 15 to 20 percent of the total recreation area.

Since the Plans Formulation Subcommittee set the target date for the early action program back from 1980 to 1985, because of the closeness of the year

1980, the same procedure will be followed in this plan. Needs for acres of developed land by activity were adjusted from 1980 to 1985 by increasing them by a proportionate share of the increase in needs between 1980 and 2000. Needs for 1985 are set forth in Table 16.

Table 16

Adjustment of 1980 Needs to 1985

	Needs in Acres of Developed Land		25% of Diff.	Needs in Acres of Developed Land
	1980	2000		1985
Basin Summary				
Swimming (land)	118	288	42	161
Boating and (land)	284	567	71	355
Water Skiing (water)	38,500	108,300	17,500	56,000
Camping	450	1,381	233	682
Picnicking	487	1,247	190	677
Parking	336	756	105	441
Jackson Subarea				
Swimming (land)	10	28	5	15
Boating and (land)	25	56	8	33
Water Skiing(water)	600	8,600	2,000	2,600
Camping	(18)*	82	25	7
Picnicking	4	84	20	24
Parking	25	70	11	36
Lansing Subarea				
Swimming (land)	45	85	10	55
Boating and (land)	77	146	20	97
Water Skiing(water)	17,100	33,900	4,200	21,300
Camping	153	381	57	210
Picnicking	152	337	46	198
Parking	107	209	26	133
West Central				
Swimming (land)	21	67	11	32
Boating and (land)	62	137	19	81
Water Skiing(water)	2,900	20,900	4,500	7,400
Camping	123	369	61	184
Picnicking	172	375	51	223
Parking	55	167	28	83

*Indicates Surplus

Table 16 (continued)

	Needs in Acres of Developed Land		25% of Diff.	Needs in Acres of Developed Land
Grand Rapids	1980	2000		1985
Swimming (land)	5	39	9	14
Boating and (land)	61	118	14	75
Water Skiing (water)	4,500	18,900	3,600	8,100
Camping	51	239	47	98
Picnicking	(44)	108	39	(5)
Parking	50	133	21	71
Northeast				
Swimming (land)	37	69	8	45
Boating and (land)	59	110	13	72
Water Skiing (water)	13,400	26,000	3,200	16,600
Camping	140	310	43	183
Picnicking	203	343	34	237
Parking	99	177	19	118

a. Priorities. A priority system for the utilization of existing resources and the development of new resources is established to obtain the most recreation facilities for the available dollar. Insofar as feasible, it is established as follows: (1) full utilization of existing resources, such as lakes, rivers, and State and local parks where they have underdeveloped lands; and (2) development of new facilities, such as reservoirs and valley preserves.

In addition to the establishment of the above priorities, a priority system is established for subareas with the greatest need as follows: (1) the Lansing and Northeast Subareas since they have great needs and very limited recreational opportunities; (2) the Jackson Subarea, since the Sandstone Creek Reservoir can satisfy a substantial part of the needs which cannot be satisfied in the Lansing Subarea and since this subarea receives heavy impact from the Detroit Metropolitan Area; (3) The Grand Rapids Subarea which receives very heavy impact from out-of-basin visitors along the Lake Michigan shore and from the Grand Rapids SMSA; and (4) the West Central Subarea.

b. Subarea Plans.

(1) Jackson Subarea. The Jackson Subarea, well endowed with high quality resources, is strategically located with respect to large population centers in southern Michigan. It receives heavy impact from the Detroit, Ann Arbor, and Lansing Metropolitan areas. The Detroit and Lansing SMSA's are especially short of quality resource areas for development of recreational opportunities.

(a) Needs. The Jackson Subarea shows a need in 1985 for 15 acres of swimming beach, seven acres of camping, 24 acres of picnicking, 33 acres of boat launching and parking area, 36 acres for other parking, and 2,600 acres of water surface. Need shown for camping is small. However, it must be kept in mind that, as stated previously in this report, the needs are understated in this subarea because of the empirical methodology used.

According to the Michigan Outdoor Recreation Plan, the State plans to increase the number of camp sites from 802 to 2,750 in District 13, which includes Jackson County, between 1964 and 1975. One-half of the 802 sites are located in the Waterloo Recreation Area in Jackson County. They plan to increase parking spaces by five-fold. Other needs are probably understated to a similar extent.

(b) Priorities. The Sandstone Creek Reservoir, Corps of Engineers Site No. 62, should be given high priority in this subarea, since it has excellent potential for the development of recreational facilities and since it is strategically located with respect to the Jackson, Lansing, and the Detroit SMSA's.

Second priority should be given to the development of additional camping, picnicking, and parking facilities in the Waterloo Recreation Area. Also, additional public access should be developed concurrently on natural lakes presently without public access in this subarea, but having potential for additional use.

(c) Plan of Development.

1. New Reservoirs. The Sandstone Creek Reservoir would be located about eight miles northwest of the City of Jackson and could service the Jackson and Lansing Subareas which have severe shortages of natural water surface and recreational facilities. With easy access from Interstate Highway 94, this site would be readily available to people in the Detroit and Ann Arbor metropolitan areas.

The dam for the Sandstone Reservoir would be located on Sandstone Creek in Section 21, T1S, R2W, just upstream from the Village of Thompkins Center. At an elevation of 950 feet mean sea level (m.s.l.) the surface area would be about 7,800 acres. It is proposed to store a substantial quantity of water for water quality control in this reservoir. Thus, a second dam might be constructed across the midsection of the impoundment to provide a stable pool with about 3,000 acres of surface water in the upper part of this impoundment solely for recreation and fish and wildlife uses. If this were done, the lower part of this reservoir would still provide great opportunity for the development of those activities not seriously affected by drawdown in late summer and fall.

The proposed recreation lands around the reservoir are undulating to strongly rolling and are very well suited for recreational development. There are many small tracts of woodland and broad, wooded fencerows on these upland areas. In addition to the lands required for the impoundment, about 5,000 acres should be acquired for development of recreational facilities.

This proposed reservoir site will support a broad range of recreational activities. The State of Michigan considers this to be one of the best, if not the best, potential site for recreational development in the southern half of the lower peninsula. The site is well located with respect to large urban centers and highway arteries. No other site in the southeastern part of the State can approach this one for recreational potential.

2. Existing Recreation Areas and Lakes. Additional camping, picnicking, and related facilities should be developed in the Waterloo Recreation area. However, this area provides little, if any, opportunity for the development of facilities for most water-dependent activities. According to the State of Michigan, most of the lakes are being utilized to their full capacity, but public access should be acquired on those with unused recreation potential.

(d) Amount of Development. It is proposed that the following facilities be developed in these locations. Development on the Sandstone Reservoir represents the initial level only; additional development could be added in later years to meet new needs as they arise.

Acres of Developed Land

Resource Area	Swimming	Boat Access	Camping	Picnicking	Parking	Acres of Water Surface
Sandstone Reservoir	12	10	67	60	31	7,800
Waterloo Recreation Area	--	--	8	10	2	-----
Public Access on Lakes	--	5	--	--	--	-----
Total	12	15	75	70	33	7,800

(e) Percent of Needs Satisfied. This level of development will satisfy 80 percent of the swimming needs, 45 percent of the boat launching and parking needs, and 90 percent of other parking needs. It will provide a surplus in camping and picnicking, but since the Sandstone Reservoir is located near the Jackson-Lansing Subarea boundary, and since opportunities

to develop recreational facilities in the Lansing Subarea are very limited, these surpluses can be utilized to offset a part of the needs in that area.

(2) Lansing Subarea. The Lansing Subarea has only limited opportunities for the development of major recreation areas. Much of the land has low relief presenting only limited opportunities for the development of good reservoirs. In planning, consideration should be given to transferring some of the needs to other Subareas.

(a) Needs. The Lansing Subarea will have a need for the development of 55 acres of swimming beaches, 97 acres of boat launching and parking area, 210 acres of camping area, 198 acres of picnic area, 133 acres of other parking area, and 21,300 acres of water surface by 1985. Needs for other activities are also present, but they were not calculated individually.

(b) Priorities. First priority should be given to the completion of Sleepy Hollow State Park. Initial facilities proposed for this park are already included in programmed supply. Also, public access should be developed on those lakes that can provide a significant amount of recreational opportunities.

Since natural features that can supply substantial amounts of recreational opportunities are so limited, second priority should be given to the development of three reservoir sites for recreational development; they are, in order of need, the Doan Creek site, Corps of Engineers site No. 59, located about 15 miles southeast of Lansing; the Portland site, Corps of Engineers site No. 51, lying astride the Lansing - West Central Subarea boundary near Portland; and the No Name Creek site, Soil Conservation Service site No. 180, near Charlotte in Eaton County.

Third priority should be given to the initiation of the development of the valley preserve system along the Grand River.

(c) Plan of Development.

1. Existing Recreation Areas and Lakes. The Sleepy Hollow State Park should be developed to its ultimate potential as soon as possible. This will include the construction of additional camping, picnicking, and parking facilities.

2. New Reservoirs. The Doan Creek reservoir would provide recreational opportunities for the Lansing, Flint, and Detroit Metropolitan areas. The reservoir would be located on Doan Creek, a tributary of the Red Cedar River, about three miles southeast of the City of Williamston and about 15 miles southeast of Lansing. The structure would be located in

Section 17 and 18, T3N, R2E in Ingham County. The pool would contain a surface area of 2,600 acres at an elevation of 900 feet and would be used exclusively for recreation, fish, and wildlife.

The lands immediately adjacent to the pool are undulating to sloping with dominate slopes of three to 15 percent. Lands lying beyond one-eighth to one-quarter of a mile from the pool generally have slopes of less than three percent and are used intensively for agriculture. About 2,000 acres of land should be acquired for the development of recreation facilities. This reservoir would support a relatively wide range of recreation facilities.

The Portland Reservoir site, lying only 18 miles northwest of Lansing and 40 miles east of Grand Rapids, would provide recreational opportunities to people in these metropolitan areas. The structure for this reservoir would be located in Section 34, T6N, R5W on the Lookingglass River about one mile east of the City of Portland in Ionia County. The conservation pool would contain about 1,300 acres at an elevation of 760 feet. This reservoir would also provide storage for flood flows.

The lands adjacent to the pool are undulating to strongly rolling with slopes of three to fifteen percent being dominant. About 2,500 acres should be acquired for the development of recreational facilities. This reservoir would support a wide range of recreational activities.

The No Name Reservoir would be located in Section 2, T3N, R5W, on a small tributary of the Thornapple River about seven miles north of the city of Charlotte. It would service the Lansing and Battle Creek metropolitan areas and several local communities. The pool would contain about 300 acres at an elevation of 895 feet. It would be used exclusively for recreation, fish, and wildlife.

The land adjacent to the proposed reservoir is undulating to sloping with slopes of three to about ten percent. In addition to land for the impoundment, about 1,200 acres of land should be acquired for the development of land-based recreation facilities. This reservoir would support a general mix of recreational activities, but due to the limited water surface powerboating and water skiing should not be permitted.

3. Valley Preserve. The valley preserve should be initiated in the area along the Grand River upstream from Lansing. This system should be extended into the City of Lansing as rapidly as possible and below the city in anticipation of improvement in water quality in the river for limited recreational use.

(d) Amount of Development. A summary of proposed initial development on the three reservoirs, Sleepy Hollow State Park and the valley preserve system would include development of the following land areas.

Acres of Developed Land

Resource Area	Swimming	Boat Access	Camping	Picnicking	Parking	Acres of Water Surface
Sleepy Hollow State Park	4	--	12	60	17	-----
Portland Reservoir	6	5	40	33	17	1,300
Doan Creek Reservoir	5	4	20	27	13	2,600
No Name Reservoir	5	2	20	20	12	300
Valley Preserve System	--	2	--	5	4	-----
Total	20	13	92	145	63	4,200

(e) Percent of Needs Satisfied. This level of development will satisfy about 36 percent of the swimming needs, about 13 percent of boat launching and parking needs, about 43 percent of camping needs, about 73 percent of picnicking needs, about 47 percent of other parking needs, and about 20 percent of water surface needs. However, a significant portion of the needs not satisfied in this subarea can be satisfied in the Sandstone Reservoir, only 30 miles from Lansing, and the Waterloo Recreation Areas in the Jackson Subarea. Also, local governments can satisfy a portion of the unmet needs.

(3) West Central Subarea. The West Central Subarea contains many resources with potential for the development of additional recreational facilities. Among them are natural lakes, existing recreation areas, good reservoir sites and broad river valleys.

(a) Needs. The needs in the West Central Subarea amount to 32 acres for swimming, 81 acres for boat launching and parking, 184 acres for camping, 223 acres for picnicking, 85 acres for other parking, and about 7,400 acres of water surface by 1985. In addition, there are needs for other activities but they were not calculated individually.

(b) Priorities. First priority should be given to providing additional development in existing State and county parks where undeveloped lands are available and to providing public access on those lakes that have significant additional potential for use.

Second priority should be given to the construction and development of Prairie Creek Reservoir, Corps of Engineers site No. 42. Also, the valley preserve system should be developed from this site downstream to the junction of Prairie Creek with the Grand River and along the Grand River to the Ionia Recreation Area on the south bank.

Duck Creek Reservoir, Corps of Engineers site No. 25 and Fish Creek Reservoir, Corps of Engineers site No. 47A, should be considered in the third priority position for recreational facilities to meet 1985 needs with Duck Creek being constructed first.

(c) Plan of Development

1. Existing Recreation Areas and Lakes. There are two State Recreation Areas, Yankee Springs on Gun Lake in Barry County and Ionia Recreation Area near Ionia in this Subarea. Also, the new Newaygo State Park is located just north of the Basin boundary in Newaygo County. All of them have potential for additional development of recreational facilities which should be installed as soon as possible.

Less than ten percent of the total land area in the Yankee Springs Recreation Area has been developed for intensive use. This area can accommodate additional swimming, camping, picnicking, and related land-based activities.

The Ionia Recreation Area containing about 3,700 acres is in the early stages of development. While the water surface is only 85 acres, this area has nearly four miles of frontage along the Grand River. There is sufficient undeveloped land to accommodate additional picnicking and other related land-based facilities. Much of the facilities proposed for this area have been included in programmed supply.

The new Newaygo State Park on Hardee Dam Reservoir on the Muskegon River can accommodate boating, fishing, camping, picnicking, and other land-based activities. This area will total about 900 acres of land when it is completed.

While this subarea has many lakes currently without public access, most of them are relatively small and have been preempted with private development which limits the potential for development of public facilities. However, public access and sanitary facilities should be provided as a bare minimum on those lakes that have unused recreational potential.

2. New Reservoirs. The Prairie Creek Reservoir would be located about two miles north of the City of Ionia, about 35 miles northwest of Lansing, and the same distance east of Grand Rapids. It would service a large area with limited available recreational opportunities. The structure for this reservoir would be located in Section 9, T7N, R6W on Prairie Creek in Ionia County. At an elevation of 746 feet, the conservation pool would be about 1,200 acres. This reservoir would also have some flood storage in it.

The lands surrounding this pool are sloping to strongly sloping with dominant slopes ranging from about four to 15 percent. The land is well adapted for recreational development and contains a number of scattered wooded areas. In addition to the area required for the impoundment, at least 2,500 acres of land should be acquired for the development of recreational facilities.

The Duck Creek Reservoir would be located on Duck Creek, a tributary of the Coldwater River, about ten miles north of the City of Hastings. The site is located about 20 miles southeast of Grand Rapids and would service this metropolitan area as well as several smaller metropolitan areas to the south.

The structure site would be located in Section 29, T5N, R8W in Ionia County. At an elevation of 820 feet, the pool would contain 940 acres of surface water. Other uses in this reservoir include fish and wildlife.

The adjacent lands are undulating to rolling with dominant slopes ranging from three to about 12 percent. Much of the adjacent land is now used for pasture and farm crops; scattered areas of woodlands are also present. In addition to the land needed for the impoundment, at least 2,000 acres of land should be acquired for the development of recreational facilities.

Fish Creek Reservoir would be located just north of the Village of Hubbardston about 30 miles northwest of Lansing and about 40 miles east of Grand Rapids. This reservoir could provide additional recreational opportunities to these and several smaller communities.

The structure site is located in Section 36, T9N, R5W in Montcalm County. At an elevation of 750 feet, the pool would contain about 3,200 acres of water. It would be used for recreation, fish, and wildlife.

The adjacent lands are undulating to sloping with dominant slopes ranging from three to about ten percent. Much of the adjacent land is now used for pasture, woodland, and some farm crops. About 3,000 acres of land should be acquired for recreational development in addition to the pool area.

3. Valley Preserves. The floodplain along Prairie Creek between the Prairie Creek Reservoir and the Grand River, should be acquired at the same time that the reservoir is constructed. This segment of the valley preserve should be extended downstream along the Grand River and be tied into the Ionia Recreation Area and eventually into a valley preserve system extending along the entire length of the Grand River. Development of recreational facilities in this area should be limited to trails, picnicking, and other compatible activities.

(d) Amount of Development. The following development is suggested for each of the resource areas proposed for development in this subarea.

	Acres of Developed Land					
Resource Area	Swimming	Boat Access	Camping	Picnicking	Parking	Acres of Water Surface
Yankee Springs Rec. Area	3	--	25	20	9	-----
Ionia Recreation Area	--	--	--	40	8	-----
Newaygo State Park	--	3	50	15	3	-----
Prairie Creek Reservoir	5	9	40	27	13	1,200
Duck Creek Reservoir	5	7	33	26	11	940
Fish Creek Reservoir	5	18	40	30	13	3,200
Public Access on Lakes	--	10	--	--	--	-----
Total	18	47	188	158	57	5,340

(e) Percent of Needs Satisfied. The proposed level of development would satisfy about 56 percent of the swimming needs, about 58 percent of the boat launching and parking needs, about 102 percent of camping needs, about 70 percent of picnicking needs, about 68 percent of parking needs, and about 72 percent of water surface needs. A significant portion of those needs not satisfied on the proposed developments could be satisfied by the development of recreation facilities at the county or city level.

(4) Grand Rapids Subarea. The Grand Rapids Subarea contains a varied assortment of resources with potential for recreation use. Among them are Lake Michigan, together with several State parks, natural lakes, good reservoir sites and broad river valleys.

(a) Needs. Needs for developed land in the Grand Rapids Subarea amount to 14 acres of swimming beaches, 75 acres of boat launching and parking area, 98 acres of camping area, 71 acres of parking area, and 8,100 acres of water surface by 1985. There is no demonstrated need for picnicking, since Kent County has developed extensive areas for this activity. However, some picnic facilities should be included in new developments to provide a well balanced facility. Although they were not caluclated individually, needs for other activities exist in substantial quantities.

(b) Priorities. First priority should be given to completion of the development of the J.P. Hoffmaster State Park on the Lake Michigan shore and to the acquisition of access sites on those inland lakes that have potential for recreational use.

Second priority should be given to the initiation of development of the valley preserve system along the Grand River, upstream from Grand Rapids. This system should be extended both upstream as need dictates and downstream as need and water quality permit.

The construction of two reservoirs should receive third priority. They are the Rogue River site, Corps of Engineers site No. 19A, and Sand Creek site, Corps of Engineers site No. 74.

(c) Proposed Development.

1. Existing Recreation Areas and Lakes. The J.P. Hoffmaster State Park can support additional development in addition to that already included in programmed supply. Therefore, expansion of recreation facilities in this park area should continue until its full potential is reached. This area can provide additional opportunities for swimming, picnicking, and other related land-based activities. Public access sites should be developed on all lakes where such facilities are not now available and where a significant amount of boating and fishing opportunities can be obtained.

2. Valley Preserves. A valley preserve system should be initiated and developed upstream from Grand Rapids. This system should be extended into the urban area as far as is practical. The first phase of this program should continue upstream for a distance of at least ten miles. When the Rogue River Reservoir is built, the valley preserve system should be extended from the Grand River Valley up the Rogue River to the recrea-

tion area on this reservoir. A valley preserve system in this area could provide opportunities for swimming, boating, camping, picnicking, and other land-based activities. If swimming facilities cannot be developed along the river banks, such facilities can be developed adjacent to the stream. Boating opportunities can be increased to some extent by the construction of low-head dams.

3. New Reservoirs. The Sand Creek Reservoir would be located about six miles west of the City of Grand Rapids. It would service the Grand Rapids metropolitan area and would provide a full range of recreational activities. The structure for this reservoir would be located in Section 22, T7N, R13W on Sand Creek in Ottowa County. At an elevation 660 feet, the pool would contain about 1,470 acres. It would be used for recreation, fish, and wildife purposes.

The land around this proposed site is sloping to strongly rolling with dominant slopes ranging from four to about 12 percent. The land is well adapted for recreational development. Much of it is in pasture with small areas of interspersed woodlands. In addition to land for the impoundment, about 3,000 acres of land should be acquired for the development of recreation area.

The Rogue River site would be located about three miles northwest of the City of Rockford and about ten miles north of Grand Rapids. It would service the Grand Rapids and Muskegon metropolitan areas as well as numerous smaller communities. It could provide a full range of recreational activities.

The structure for this reservoir would be located in Sections 22 and 23, T9N, R11W on the Rogue River in Kent County. At an elevation of 735 feet, the pool would contain about 3,300 acres. It would be used for recreation, fish, and wildlife.

The land around this site is undulating to rolling with dominant slopes ranging from three to about ten percent. It is well adapted for recreational development. At the present time, most of it is in pasture with some woodland, although some of it is cropped and some is idle. In addition to the land for the reservoir, about 4,000 acres of land should be acquired for the recreation area.

(d) Amount of Proposed Development. The following development is suggested for each of the resource areas proposed in this subarea:

AD-A044 057 GRAND RIVER BASIN COORDINATING COMMITTEE DETROIT MI F/G 8/6
GRAND RIVER BASIN MICHIGAN. COMPREHENSIVE WATER RESOURCES STUDY--ETC(U)
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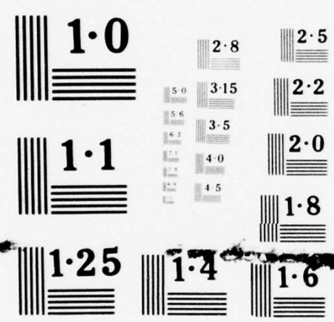


NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

Acres of Developed Land

Resource Area	Swim-ming	Boat Access	Camp-ing	Picnick-ing	Park-ing	Acres of Water Surface
Hoffmaster State Park	20	--	--	20	37	--
Public Access on Lakes	--	10	--	--	--	--
Valley Preserve System	3	5	10	10	8	--
Sand Creek Reservoir	8	6	30	20	17	1,470
Rogue River Res-ervoir	5	4	30	20	12	3,300
Total	36	25	70	70	74	4,700

(e) Percent of Total Need Satisfied. The proposed level of development would satisfy about 53 percent of the boat launching and parking needs, about 71 percent of camping needs, about 72 percent of the parking needs, and about 58 percent of water surface needs and would provide a surplus in swimming. The picnicking would be in excess of needs, but some picnic facilities are needed on the new areas to provide a balance of activities.

(5) Northeast Subarea. Opportunities for the development of recreational facilities in this subarea are very limited. There are very few natural lakes, no major floodplains, no State parks, very few local parks, and very limited opportunities for the development of water surface area. Therefore, some of the needs prorated to this subarea will probably have to be satisfied in other adjacent areas.

(a) Needs. Needs for acres of developed land in the Northeast Subarea amount to 45 acres of swimming beach, 72 acres of boat launching and parking, 183 acres of camping, 237 acres of picnicking, about 16,600 acres of water surface, and 118 acres of parking by 1985. There also is a need for facilities for hiking, nature walks, and other activities, but they were not calculated individually.

(b) Priorities. First priority should be given to the acquisition and development of public access on existing water surface areas, if they can support a significant amount of recreational usage.

Second priority should be given to the construction of the Lookingglass site, Soil Conservation Service site No. 148; the Grub Creek site, Soil Conservation site No. 149; and the Bear Creek site, Soil Conservation site No. 109.

Third priority should be given to meeting some of the needs of this subarea in adjacent areas where there is substantially greater opportunity for the development of recreational facilities.

(c) Proposed Development.

1. Existing Lakes. Public access sites should be acquired and developed on existing lakes to the limit that the few lakes in this subarea can support additional recreational facilities.

2. New Reservoirs. The Lookingglass and Grub Creek sites would be located about three miles southeast of the Village of Morrice and about 22 miles east of Lansing. They would service the Lansing and Flint metropolitan areas and several smaller communities in the immediate vicinity.

The structure for the Lookingglass reservoir would be located on the headwaters of the Lookingglass River in the northern part of Sections 20 and 21, T5N, R3E in Shiawasee County. At an elevation of 870 feet, this structure would create a pool of 400 acres of water. The structure for the Grub Creek Reservoir would be located on Grub Creek in Section 9, T5N, R3E in Shiawasee County. At an elevation of 870 feet, this structure would create a pool of 530 acres of water. These reservoirs would be used for recreation, fish, and wildlife.

The land in the vicinity of these two structures varies from undulating to strongly rolling with slopes ranging from three to more than 15 percent. It has substantial aesthetic qualities for recreational development. In addition to the need for the reservoirs, at least 2,000 acres of land should be acquired for the development of recreational facilities. The land between the two impoundment areas should be acquired to tie them together into a common recreation facility.

The Bear Creek site would be located about seven miles west of the City of Owosso and about 17 miles northeast of the Lansing metropolitan area. It would service the Lansing metropolitan area and several smaller communities in the immediate area.

The structure would be located in Section 26, T7N, R1E on Bear Creek, a small tributary of the Maple River in Shiawasee County. The pool would contain about 280 acres of water. The area would be used for recreation, fish, and wildlife.

The land around the impoundment is rolling to strongly rolling and is well adapted for development of recreational facilities. About 1,000 acres should be acquired for the development of the recreation area.

(d) Amount of Development. The following development is proposed for each of the resource areas considered in this subarea. Except for the water surface, the initial level of development on the proposed reservoir sites is approximately one-third of their maximum potential.

Acres of Developed Land

Resource Area	Swimming	Boat Access	Camping	Picnicking	Parking	Acres of Water Surface
Existing Lakes	--	5	--	--	--	--
Bear Creek Reservoir	4	1	20	15	9	280
Lookingglass and Grub Creek Reservoir	5	4	40	40	16	930
Total	9	10	60	55	25	1,210

(e) Percent of Total Needs Satisfied. The proposed level of development would satisfy only 20 percent of swimming needs, about 13 percent of boat launching and parking needs, about 32 percent of camping needs, about 23 percent of picnicking needs, about 20 percent of parking needs, and about seven percent of water surface needs. Many of the unmet needs will have to be satisfied in areas outside of this subarea.

(6) Basin Summary of Satisfied Needs. Total needs for developed land in the Basin amount to 161 acres for swimming, 355 acres for boat launching and parking, 682 acres for camping, 677 acres for picnicking, 447 acres for parking, and 56,000 acres of water surface. Of this total need, the following amounts are proposed for development in this plan.

Acres of Developed Land

Subarea	Swimming	Boat Access	Camping	Picnicking	Parking	Acres of Water Surface
Jackson	12	15	75	70	33	7,800
Lansing	20	13	92	145	63	4,200
West Central	18	47	188	158	57	5,340
Grand Rapids	36	25	70	70	74	4,720
Northeast	9	10	60	55	25	1,200
Total	95	110	485	498	252	23,310

The development of these facilities would provide for about 59 percent of all swimming needs, 30 percent of all boat launching and parking needs, about 71 percent of all camping needs, about 73 percent of all picnicking needs, about 56 percent of all parking needs, and about 42 percent of all water surface needs. The unmet swimming needs do not include the 33 percent of total swimming need allocated to be satisfied in swimming pools. Some of the unmet swimming, camping, picnicking needs could be satisfied by the development of additional facilities for these activities by local units of government or by the private sector.

c. Supplementary Considerations

(1) Role of Local Governments. As in the past, local units of government - counties, townships, and cities - will need to continue their role of providing a substantial portion of the total needs for development of recreational facilities. Local governments should assume much of the responsibility for the development of the valley preserve system and of recreational facilities on existing lakes. In addition to this role, they should develop the necessary facilities to satisfy the unmet needs remaining from the Basin Plan except for water surface area. The cost of developing water surface area normally would be beyond the financial capacity of local governmental entities.

(2) Role of the Private Sector. The private sector should be strongly encouraged to provide facilities to meet some of the additional needs also. At the time of the inventory of existing recreational facilities, the private sector was providing nearly 20 percent of all camping spaces in the eleven county area. It also provides a small but unknown amount of swimming and picnicking facilities.

The private sector can only be exptected to provide recreational opportunities and facilities where the economic return from such investment justifies the risk of the investment. The private sector should be encouraged to continue to supply camping, swimming, picnicking, and related opportunities for the public. It is believed that many people would pay a reasonable fee to swim in natural lakes where good beaches can be developed and where water quality is acceptable. Picnic facilities can readily be provided at a nominal cost in association with swimming facilities. Those who own suitable lands on private lakes should be encouraged to develop such resources for public use.

Another area where the private investor can function effectively is the construction and management of boat marinas. If private investors can be encouraged to function in these areas, more public funds will be available for the development of those recreational facilities that do not attract the private investor.

(3) Preservation of Outstanding Resources. Attention should be given to areas that have significant or unusual aesthetic or historic value. The significance may be of local, State, or national importance. These areas would contain such features as virgin, unusual, or outstanding communities of plant life; outstanding populations of animal life; or outstanding structures, such as historic building, old bridges, etc. These features are being identified by the National Park Service.

When features of significant value are discovered within the area to be inundated or affected by inundation, every approach available should be explored to determine the most logical and feasible method to protect, relocate such features, or relocate the proposed structure with respect to such important features. Although it is desirable to provide water-oriented outdoor recreation opportunities which will accommodate large numbers of people, it is also important to protect areas of natural beauty, such as Coldwater Creek in Kent County, for those who desire the quiet peacefulness of nature.

(a) Wild, Scenic, and Recreational Rivers. There are no rivers in this basin which have been recommended as a wild, scenic, or recreational river. However, the Coldwater River, a tributary of the Thornapple River, is noted chiefly for its clean, cold waters rippling over beds of gravel, its wooded stream banks, and the rolling hills, some wooded, rising to the north and south. The lower part of the Flat River also flows through some very scenic landscapes. While these rivers do not possess the unusual characteristics of a wild, scenic, or recreational river by national standards, they have certain qualities which need to be considered for preservation by the State for local needs.

(b) National and State Trails. The North Country Trail is proposed to cross the Grand River Basin along the Lake Michigan shore in western Ottawa County. An alternate route proposed for study passes north and south through the eastern parts of Jackson and Ingham Counties and the central part of Shiawasee County. As the valley preserve concept is envisioned, a continuous trail system should be developed from the Sandstone Creek reservoir, northwest of Jackson, along the Grand River Valley to its confluence with Lake Michigan. This trail could be connected with the alternate route of the North Country Trail in eastern Jackson County, when that one is completed. If this trail were connected with Detroit through the Huron River Valley, it would provide an excellent cross-state trail, either connecting or passing many of the principal population centers of the State.

(4) The Role of Aesthetics. Site planning on each of the proposed recreation areas should be accomplished in a manner to preserve as much of the natural beauty of the recreation area as possible. Since wooded areas are limited in extent, they should be protected from excessive traffic. Intensive use areas should be located some distance from unique areas of biological life. Where areas are deficient in shade, trees should be planted. In general, any reasonable measure that will protect or enhance the aesthetic qualities of recreational areas should be applied.

(5) Alternatives Outside of the Basin. Many recreational opportunities have been developed on lakes and rivers to the north of the Grand River Basin. However, over the last few years, many of these facilities have been crowded beyond their capacity, especially for camping and boating. Additional water surface could be made available on some of those lakes presently without public access. Opportunities for camping, picnicking, hiking, and related land-based activities could be developed in State and National forest areas, but most of these areas would have only limited area of water surface. However, the potential of each of these resource areas should be developed to its full capacity as need arises within the area or as unsatisfied needs are transferred from overcrowded areas.

Recreational facilities to the south and east are already used beyond their capacity. There appears to be little or no opportunity to satisfy a portion of the Grand River Basin needs in this general direction.

The Lake Michigan shore presents excellent opportunities for the development of swimming, camping, picnicking, trails, and other related activities. However, except for the Grand Rapids Subarea, this resource is rather far removed from other subareas to effectively service day-use needs. In addition, much of the Lake Michigan shoreline is privately owned in small parcels as residential property, especially in the southern part of the State; thus, the acquisition and development of this resource is costly and limited. This

resource base serves large quantities of week-end and vacation users who come into the area from the east and south.

(6) Supporting Programs. There is no single solution that will relieve the water shortage during the recreation season. All measures that might make more water and other facilities available should be explored and included in a recreation plan. A number of measures are available to support and strengthen the carrying capacity of existing and new facilities. These measures include both physical and regulatory practices which, if applied vigorously to protect and improve water quality, would increase the efficiency of the use of water resources. Such measures should be established by the proper governmental entity where they are feasible, and they should be administered unequivocally to prevent development which would impair the aesthetic and recreational values of streams and lakes.

(a) Water Quality Control. The effectiveness of any recreation plan is directly tied into the quality of water available for use. Any area of water lost through pollution reduces the supply by that amount and increases the pressures for use on already deficient supplies of recreational facilities. Water cannot be considered available for recreation use unless it is of suitable quality. Minimum quality standards permit partial body contact, but the goal should be a quality of water that will permit whole body contact. There are two independent qualities which must be assumed in recreation waters: the absence of health hazards and desirable aesthetic qualities.

Pollution can affect recreation activities in several ways. Swimmers and water skiers coming in direct contact with the water are subject to illnesses caused by pathogenic organisms from human wastes. Such dangers are clearly illustrated in Plate 26. Turbidity caused by sediments or algal growth increases risks to swimming by reducing visibility under water. Contact with or ingestion of chemical wastes, pesticides, and similar products can cause serious injury to swimmers and others in such waters. The boater's primary concern is physical damage to equipment by extreme acidity, alkalinity, floating debris, or chemical wastes.

All water-dependent and water-enhanced activities are adversely affected by visible floating, suspended, or settled solids; arising from the disposal of sewage or garbage; sludge banks; slime infestation, heavy growths of attached plants or animals; blooms of high concentrations of plankton; discoloration or excessive turbidity from sewage, industrial wastes, or even natural sources; the evolution of dissolved gases, especially hydrogen sulphide; visible oil or grease, including emulsions; excessive acidity or alkalinity that leads to delignification of boats and docks; surfactants that foam when water is agitated or aerated; and excessive temperatures that cause high rates of evaporation and cloudiness over the water. Even the residue of the beauty of nature, as shown in Plate 27, can create problems for recreators and officials alike.

Plate 26--*This boy's hopes for recreation have been disappointed by the polluted waters.* (Photo courtesy of Michigan Department of Natural Resources)

Plate 27--*Pollutants in the form of sediments eroded from this hillside impaired water quality and the potentail for recreation.* (Photo courtesy of Michigan Department of Natural Resources)

Recreation is adversely affected by all improperly treated municipal and industrial wastes. Waters returned to streams or lakes from sewage treatment plants usually contain pathogenic organisms and/or other polluting materials. In addition, waste-waters commonly have offensive odors, tastes, or turbidity, which limit the aesthetic value as well as the direct uses of water. Solid wastes are often discarded or stored in any place where they can degrade water. More specific information concerning water quality criteria is given in Appendix G, Water Use and Stream Quality.

Many private residences are located on or near the shores of lakes and banks of streams in the basin. Most of them are serviced with individual, inefficient sewage treatment systems which permit sewage wastes to seep into adjacent waters. Such pollutants commonly enter waters used for recreation or having potential for recreational use and degrade them below safe limits.

Agriculture is responsible for several types of pollutants such as sediments resulting from soil erosion (see Plate 27), residues from pesticides, and the leaching of nutrients from animal wastes and soils. Sedimentation commonly reduces the quality of water both physically and chemically. Land is often put to those uses for which it is not well adapted; frequently, land and water conservation practices are not adequately and properly applied.

The control of residues from pesticides and leaching of nutrients from animal wastes and soils presents an unsolved problem. A rapid acceleration in research is needed to solve these problems before they become insurmountable.

The construction industry permits substantial quantities of soil sediments to enter water courses near construction areas. They make little effort to apply proven control measures to reduce this source of sediments to a minimum. They have failed to cooperate in evolving new techniques to control this source of pollutants more effectively.

(b) Zoning. Zoning can be an effective tool when it is appropriately and impartially applied. Two types of zoning are available: (1) zoning of land use, and (2) time zoning.

Zoning of land use is designed to control uses to which land can be put. Intensive development of cottages and residences along streams and lakes commonly causes a severe deterioration of water quality. The proper application of zoning has not been used to control the degree of development on and near the shorelines. Complementary regulations - such as controls on the use of septic tanks, subdivision regulations, and housing codes - controlling the disposal of waste water have been little used by the appropriate agency to protect the quality of water.

All to frequently there is pressure by private individuals, groups, or institutions to develop floodplains for residential, commercial, or industrial uses and then to request protection of such investments with expensive dams and channel improvements built by government. The zoning of floodplains for recreational and other compatible uses subject to only limited or no damage by flooding is an alternative to urban development. Many recreational facilities are not subject to intensive damage from flooding. The State of Wisconsin has enacted legislation that requires counties to establish land use controls on floodplains and lake frontages. Wisconsin will establish such controls for those counties that fail to respond within a given time period. Such legislation in Michigan would control undesirable development on floodplains and lakeshores and would permit the effective development of a large recreation increase through coming decades.

Time zoning is the establishment of regulations to control the time of day that recreators can participate in certain water-based activities, such as water skiing. Such measures are useful to reduce or eliminate conflict among various uses and tend to increase the total opportunity for participation in recreation activities on a given area of water.

(c) Water Re-use. If it is properly treated, water can be used over and over again by industries and municipalities. Careful accounting of water usage should be maintained to ensure optimum availability of fresh water in surface and ground water supplies.

d. Scale of Development. The scale of recreational development set forth on reservoir sites in the Plan of Development represents approximately one-third of the ultimate capacity of these facilities. The development of additional recreational facilities in post-1985 would satisfy a substantial part of additional needs as they arise.

On existing State parks, the scale of development is designed to bring these facilities to their ultimate capacity as now planned by the State of Michigan. Where public accesses are developed on natural lakes, they could be expected to reach their safe ultimate capacity for water-based activities within a few years.

The development proposed on the valley preserve system would represent only a small beginning of the ultimate potential of a basin-wide system. This system, like the proposed reservoirs, could satisfy a vast amount of recreation needs in the post-1985 period.

Table 17 shows the initial and ultimate levels of visitation that could be expected on these proposed recreation developments for the eight activities used in this study.

Table 17

Levels of Initial and Ultimate Visitation

Proposed Recreation Development	Reservoir Number	Visitation in Recreation Days Initial (1985)		Ultimate	
Rogue River	19A	286,000		1,669,000	
Duck Creek	25	287,000		746,000	
Prairie Creek	42	302,000		912,000	
Fish Creek	47A	340,000		1,159,000	
Portland	51	356,000		1,121,000	
Doan Creek	59	291,000		883,000	
Sandstone Creek	62	886,000		2,275,000	
Sand Creek	74	339,000		1,209,000	
Bear Creek	109	191,000		456,000	
Lookingglass and Grub Creek	148 and 149	369,000		1,107,000	
No Name Creek	180	245,000		596,000	
Subtotal			3,892,000		12,035,000
Hoffmaster State Park		566,000*			
Ionia Recreation Area		153,000*			
Newaygo State Park		165,000*			
Sleepy Hollow		346,000*			
Waterloo Recreation Area		51,000*			
Yankee Springs		190,000*			
Lake Access, West Central Subarea		92,000*			
Lake Access, Grand Rapids Subarea		92,000*			
Subtotal			1,655,000		
Valley Preserve (Grand Rapids)		177,000		875,000	
Valley Preserve (Lansing		37,000		210,000	
Subtotal			214,000		1,085,000
Total			5,761,000		13,120,000

*These visitation figures are considered to be ultimate although they will occur by 1985.

In addition to recreation needs, consideration must be given to needs for flood control, water supply, and other uses for water. It is apparent that one or more of these needs will require the development of additional extensive acreages by the year 2020. No estimate of them is available at this time.

e. Scheduling of Development. Development priorities are based on unsatisfied demand by subarea and activity. The greatest unsatisfied demand for outdoor recreation within the basin emanates from the Lansing and Northeast Subareas. They have very few natural water resources suitable for recreational development. Therefore, it will be necessary to rely mainly on impounded water to satisfy the recreation demand in these areas.

Of the 12 reservoirs proposed in the Plan of Development, consideration should be given to their construction in the following order: Sandstone Creek, Doan Creek, and Bear Creek should receive first priority; Portland, No Name Creek, Prairie Creek, and the Lookingglass-Grub Creek complex should receive second priority; and Sand Creek, Rogue River, Duck Creek, and Fish Creek should be held for third priority.

The first priority reservoirs are either located in or near the Lansing and Northeast Subareas, areas of great needs. The second priority group would add recreational facilities to the areas of greatest need and would initiate the development of needed facilities west of Lansing where water surface is relatively limited. Construction of the third group would complete the reservoir phase of the recreation plan proposed to satisfy 1985 recreation needs.

The Sandstone Creek, Doan Creek, Portland, Bear Creek, No Name Creek, and Lookingglass-Grub Creek reservoir sites make up about all of the most desirable sites in the eastern part of the Basin. The Sand Creek and Rogue River sites are located relatively close to the rapidly growing Grand Rapids SMSA. The Prairie and Fish Creek sites are in areas relatively devoid of water surface. They, together with the Duck Creek site, lie somewhat farther removed from urban centers and could be developed with greater emphasis on weekend use.

Most of the subareas have greater or lesser amounts of natural waters that lend themselves to development. Programs should be initiated to make optimum use of existing natural resources through acquisition and development of abutting land. The more than 15,000 acres of water in lakes without public access and 5,000 acres in rivers with very limited access provide an excellent opportunity to obtain additional land and water for recreational use. As much of these resources as is feasible should be acquired and developed as soon as possible.

17. SUGGESTED ADMINISTRATIVE ARRANGEMENT. It is suggested that the general recreation lands and all related facilities be administered by the State of Michigan or local governmental entities in accordance with the provisions of Public Law 89-72.

18. RELATIONSHIP OF THIS PLAN TO PLANS OF REGIONAL AND NATIONAL SCOPE. The relationship of this proposed recreation plan to planning presently being conducted by the Great Lakes Basin Commission and to other comprehensive planning in the nation should be examined. Such considerations are necessary to determine that this increment of the regional and national plan is compatible with the broader aspects of planning.

a. At the Regional Level. The Grand River Basin Comprehensive Study was authorized before the Great Lakes Basin Commission was established. Thus, the study was well along before the Great Lakes Basin Commission initiated a Type I Comprehensive study on the Great Lakes Region. However, the Grand River Basin Study of recreation was conducted in a manner that is compatible with the broad overview approach being used in the Great Lakes Basin. With the exception of Gratiot County included in the Grand River Comprehensive Study, this river basin along with the Kalamazoo and St. Joseph River Basins comprise Planning Subarea 2.3 of the Great Lakes Basin study area. The Grand River Basin Comprehensive Study will provide substantial input to the planning for Planning Subarea 2.3 of the Great Lakes Basin Comprehensive study and the basin plan will function as a part of the overall Great Lakes Basin plan. Thus, it will be the second river basin in the Great Lakes Basin to have a detailed plan for needed development of recreational facilities. The Genesee River Basin in New York State was the first.

In light of this broader overview, the various elements set forth in the recreation plan of this section will need to be weighed against needs for water resource development in other parts of the Great Lakes Basin. After the needs for the Great Lakes Basin have been determined by the Great Lakes Basin Comprehensive Type I and subsequent studies, priorities for development of needed projects will be established. Such priorities could override the immediate priorities set forth for the development of the proposed projects in the early action phase of this recreation plan.

b. At the National Level. The need for water resource development at the national level through the year 2020 is being explored through a series of 18 broad overview (Comprehensive Type I) river basin studies covering the entire nation. Many of these studies are either now underway or have been completed. One of the primary purposes of these studies is to identify those river basins needing greater in-depth study than can be accomplished through a Comprehensive Type I study and to establish a priority system for the in-depth studies.

The Grand River Basin Comprehensive study along with several other river basins was authorized for Comprehensive Type II studies by Congress early in the national planning program. Thus, the Grand River Basin Comprehensive Study, through the Great Lakes Basin Comprehensive Study, is a part of the total national planning program for the development of water and related land resources. The requirements for recreational facilities set forth in this Appendix and in Appendix Q (the Basin Plan) will need to be weighed against requirements for water and related land resource development proposed in other river basin studies in the nation. Priorities will be established by Congress for development of water resource facilities according to areas of greatest needs within the limits of financial resources of the nation. Thus, this recreation plan, as carried forward into the overall basin plan, will provide necessary data to enable Congress to establish priorities and make decisions regarding the development of water and related land resource facilities in this and other river basins.

SECTION V

EVALUATION

19. BENEFITS. Recreation benefits were based on the premise that the proposed recreation plan in Section IV would be implemented and ready for use by 1985.

a. Tangible. A number of factors affect the value of a given water impoundment for recreational use. These factors vary with the use which the impounded water in any given reservoir is to be employed.

Normally when a reservoir is used solely for recreation purposes, the benefits received from it have a somewhat higher value per recreation day than they have when that reservoir is manipulated for multipurpose uses. An impoundment used exclusively for recreation has a relatively stable level of water which is essential to obtain maximum benefits for recreation. A constant level permits more economical development of launching ramps and quality bathing beaches on favorable slopes. All of these factors enhance the recreational value to the participant.

Sites with good recreational potential are relatively limited in the Grand River Basin. The group of sites selected for recreational development have a potential to provide a substantial portion of the necessary water and related resources in reasonable proximity to the greatest need.

The character of the land adjacent to the study sites adds to or subtracts from the quality of an area for recreational development. Sloping to strongly rolling lands add character to a site, whereas nearly level land presents a monotony. Further, the shore fringes of sites in very shallow basins eventually fill in with extensive growth of shallow water plants. On the other hand, steep slopes adjacent to shorelines limit the recreational opportunity by making it difficult to gain access to the water's edge.

All of these factors were considered in the assignment of an equitable value to recreation benefits. A monetary value per recreation day was determined in accordance with Senate Document 97, Supplement 1. An average value of $1.25 was placed on all recreation days which would be fulfilled by the development of resources and facilities set forth in the recreation plan.

The number of recreation days was obtained from the five water-oriented activities identified in the demand section. Sightseeing, hiking, and nature walks also contribute to benefits, and visitations accruing to these activities were calculated as a percentage of the five major activities.

Average annual equivalent benefits were calculated from the product of ultimate visitation in recreation days and value per unit day. For all long term development projects - reservoirs and valley preserves - Curve No. 2 from Technical Paper No. 5 by Lester M. Duck and Paul F. Beard, Corps of Engineers, was used in deriving the average annual equivalent benefit. See Plate 28. This curve shows that an initial level of visitation, about 30 percent of the ultimate level, will be attained about three years after completion of the project. About 85 percent of the ultimate level will be reached about 50 years after completion of the project. Curve No. 7 was used to derive the benefits for all other projects which will be completed and in full use over a relatively short period of time. This curve shows that about 50 percent of the ultimate visitation will be attained in the first year and that ultimate visitation will be reached within about 20 years of completion of the project. Benefits were discounted at a rate of 4-7/8 percent over a period of 100 years.

A summary of estimates of recreation days that would be satisfied in the Basin and the monetary benefits in average annual equivalents is presented in Table 18.

Table 18

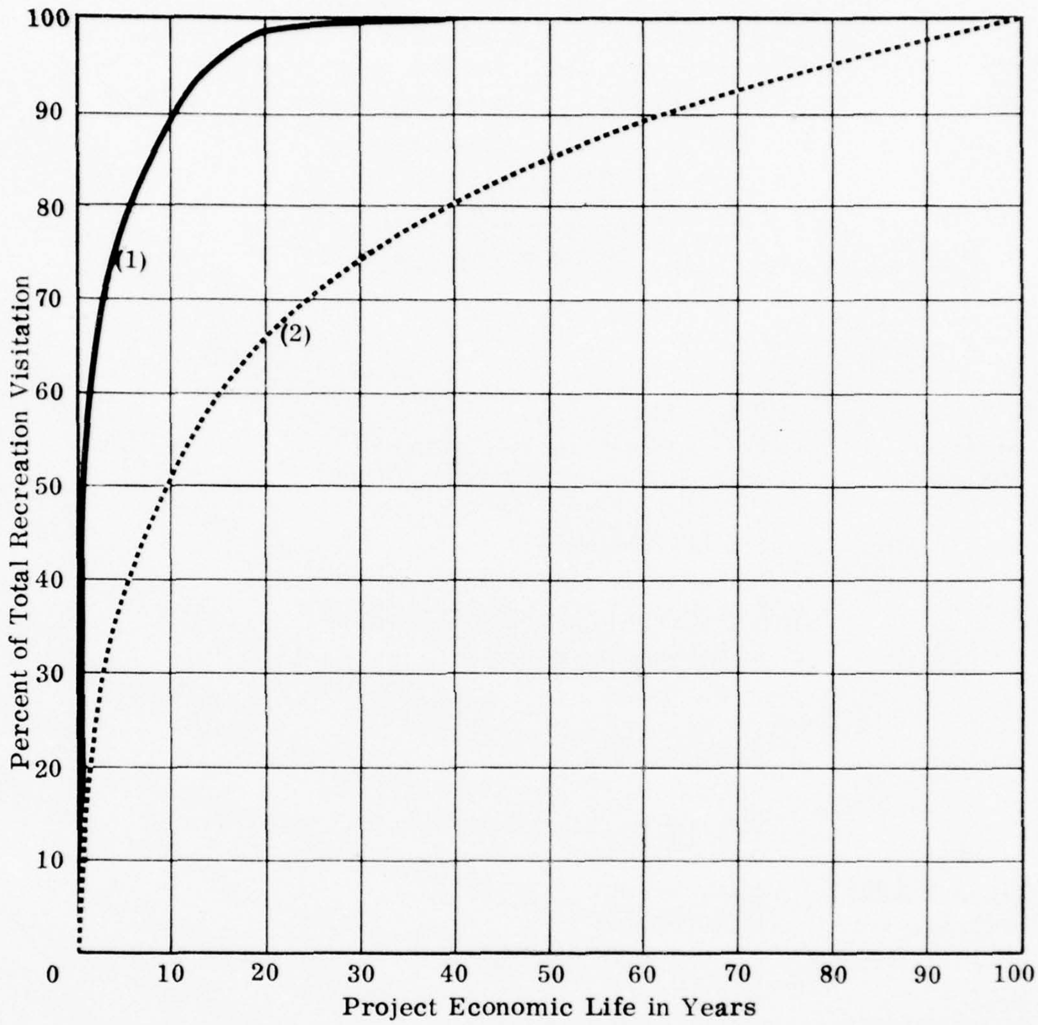
Basin Summary of Recreation Days
and Average Annual Equivalent Benefits

Subarea	Visitation in Recreation Days Ultimate	Average Annual Equivalent Benefits
Jackson	2,326,000	$ 1,687,000
Lansing	3,246,000	2,352,000
West Central	3,417,000	2,481,000
Grand Rapids	4,411,000	3,200,000
Northeast	1,609,000	1,167,000
Basin Total	15,009,000	$10,887,000

b. Intangible. No attempt has been made to compute intangible benefits in this analysis. The determination of such benefits requires a comprehensive study of individual sites.

20. COSTS. Cost estimates were based on the acquisition of land, development of facilities, and the construction of reservoirs set forth in the recreation plan in Section IV.

TYPICAL GROWTH CHARACTERISTICS OF RECREATION VISITATION
FOR TWO TYPES OF DEVELOPMENT
(Corps of Engineers Reservoirs)



Source:
Chart ORDPD-2, Feb. 1966
Revised May 1969
U. S. Army Engineer Division
Ohio River
Corps of Engineers,
Cincinnati, Ohio

Legend
Percent Of Total Attendance
Projected To Be Attained:
——— (1) 50% within 1st year
········ (2) 30% within 3 years

Plate 28

The cost analysis was developed in several basic steps which include calculations of costs for the development of the initial and future increments of recreational facilities exclusive of water, calculations of the cost of land and calculation of the average annual equivalents of costs. Costs were computed both for the basin as a whole, for each of the subareas, and for each major project included in the recreation plan. See Tables 19 and 20 for a complete breakdown of these cost estimates per 1,000 design load or one standard unit.

Table 19

COSTS OF FACILITIES PER STANDARD UNIT
Standard Unit - 1,000 Design Load Visits

Item			Cost per Standard Unit
Picnic Units (4 tables, fireplace)	$560/Unit 20 Visitors/Unit 50 Units/1,000 Visitors	$28,000	
Picnic Shelter	$12,000/Shelter 1 Shelter/25 Picnic Units 2 Shelters/1,000 Visitors	$24,000	
	Subtotal for Picnic Facilities		$ 52,000
Beach	$0.28/Sq. Ft. 150 Sq. Ft./Visitor* 150,000 Sq. Ft./1,000 Visitors		$ 42,000
Change House including rest-rooms, showers	$100,000/Unit 2000 Visitors/Unit 1/2 Unit/1000 Visitors		$ 50,000
Boat Launch Ramp	$18,000/Ramp Site 120 Visitors/Site 8 1/3 Sites/1,000 Visitors		$150,000
Camp Sites	$1,800/Unit 5 Visitors/Unit 200 Units/1,000 Visitors		$360,000
Parking	$140/Unit 4 Visitors/Unit 250 Units/1,000 Visitors		$ 35,000

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*This includes 100 square feet of dry beach and 50 square feet of wet beach per visitor.

Table 19 (con't)

COSTS OF FACILITIES PER STANDARD UNIT
Standard Unit - 1,000 Design Load Visits

Item		Cost Per Standard Unit
Sanitary Units	$12,000/Unit 320 Visitors/Unit 3 Units/1,000 Visitors	$ 36,000
Water Supply	$1,000/Unit 75 Visitors/Unit 14 Units/1,000 Visitors	$ 14,000
Nature Walks	$8,000/Mile 1,000 Visitors/Mile 1 Unit/1,000 Visitors	$ 8,000
Hiking	$1,000/Mile 200/Visitors Mile 5 Miles/1,000 Visitors	$ 5,000
Signs and Markers	$0.25/Visitor $250/1,000 Visitors	$ 250
Landscaping	$1.50/Visitor $1,500/1,000 Visitors	$ 1,500
Administration Building	$220,000/Unit 40,000 Visitors/Unit 1/40 Unit/1,000 Visitors	$ 6,000
Power Distribution	Average/1,000 Visitors	$ 5,000
Roads	$40,000/Mile 1 Mile/1,000 Visitors	$ 40,000
Sewage Treatment Plant (Tertiary) including collection system, etc.	$2 million/5 mgd Unit $60,000/1,000 visitors	$ 60,000

Table 20

COST OF FACILITIES BY ACTIVITY PER 1,000 DESIGN LOAD VISITS
(Standard Unit)

Activity and Facilities Needed		Cost Per Standard Unit
Swimming		
Beach		$ 42,000
Parking		35,000
Water		14,000
Power		5,000
Bath House including Sanitation		50,000
	Total	$146,000
Boating and Water Skiing		
Ramp and Parking		$150,000
Water		14,000
Power		5,000
Sanitation		36,000
	Total	$205,000
Camping		
Unit		$360,000
Picnicking		
Unit (includes shelters)		$ 52,000
Parking		35,000
Water		14,000
Power		5,000
Sanitation		36,000
	Total	$142,000
Sightseeing		
Parking		$ 35,000
Sanitation		36,000
Water		14,000
	Total	$ 85,000

Table 20 (con't)

COST OF FACILITIES BY ACTIVITY PER 1,000 DESIGN LOAD VISITS
(Standard Unit)

Activity and Facilities Needed		Cost Per Standard Unit
Nature Walks		
Parking		$ 35,000
Sanitation		36,000
Water		14,000
Trails		8,000
	Total	$ 93,000
Hiking		
Parking		$ 35,000
Sanitation		36,000
Water		14,000
Trails		5,000
	Total	$ 90,000
Signs		$ 250
Landscaping		$ 1,500
Administration Building		$ 6,000
Roads		$ 40,000
Sewage Treatment		$ 60,000

Cost of facilities was determined by multiplying the cost of facilities per standard unit for any given recreational activity by the number of standard units planned for each project in the recreation plan. The sum of these costs by activity equals the total cost of facilities. See Table 21 for a summary of these estimates by subarea and the basin. Details of these costs by project are given in Appendix E.

In the computation of cost of recreation land, it was assumed that all land needed to develop the complete recreation area to its ultimate capacity would be acquired in the initial stages. Also, it was assumed that 10 to 15 percent of the land would be developed for the basic five recreational activities used in this study. An additional three to five percent of the land will be needed for the development of facilities for those activities, such as play fields, etc., not considered in this study. The remaining 80 to 85 percent would function

Table 21

Summary of All Basin Costs

Activity and Related Needs	Jackson Subarea No. of Standard Units	Jackson Subarea Cost of Facilities (000)	Lansing Subarea No. of Standard Units	Lansing Subarea Cost of Facilities (000)	West Central Subarea No. of Standard Units	West Central Subarea Cost of Facilities (000)
Swimming	17.40	2,540	22.19	3,239	18.72	2,732
Boating & Skiing	2.90	595	2.18	408	3.31	679
Camping	8.32	2,995	9.88	3,557	19.00	6,840
Picnicking	9.50	1,349	17.00	2,414	16.75	2,379
Sightseeing	1.91	162	2.59	221	2.82	240
Nature Walks	2.36	220	3.21	300	3.48	323
Hiking	.88	79	1.21	110	1.29	116
Signs	43.23	11	56.76	14	65.35	17
Landscaping	43.23	64	56.76	85	65.35	100
Admin. Bldg.	43.23	239	56.76	341	65.35	391
Roads	43.23	1,729	56.76	2,269	65.35	2,614
Sewage Plant	43.23	2,594	56.76	3,407	65.35	3,921
Total Cost		12,577		16,365		20,352
Initial Increment		4,426		5,484		8,719
Future Increment		8,151		10,881		11,633

Table 21 (con't)

Summary of All Basin Costs

Activity and Related Needs	Grand Rapids Subarea No. Of Standard Units	Grand Rapids Subarea Cost of Facilities (000)	Northeast Subarea No. of Standard Units	Northeast Subarea Cost of Facilities (000)	Basin Total No. of Standard Units	Basin Total Cost of Facilities (000)
Swimming	36.98	5,033	9.98	1,457	105.27	15,001
Boating & Skiing	3.34	686	1.83	374	13.56	2,742
Camping	14.80	5,328	7.20	2.592	59.20	21,312
Picnicking	18.50	2,627	8.00	1,136	69.75	9,905
Sightseeing	3.12	265	1.32	112	11.76	1,000
Nature Walks	3.85	358	1.64	153	14.54	1,354
Hiking	1.42	129	.61	54	5.41	488
Signs	82.02	19	30.58	7	277.94	68
Landscaping	82.02	123	30.58	46	277.94	418
Admin. Bldg.	82.02	492	30.58	187	277.94	1,650
Roads	82.02	3,281	30.58	1,247	277.94	11,140
Sewage Plant	82.02	4,921	30.58	1,870	277.94	16,713
Total Cost		23,262		9,235		81,791
Initial Increment		7,189		3,427		29,245
Future Increment		16,073		5,808		52,546

as buffers between activities and provide space for hiking, nature walks, and sightseeing, as illustrated in Plate 29. A price of $250 per acre, used also by the Corps of Engineers, was assumed in the determination of the cost of land. However, this figure probably is too low since the State of Michigan very recently paid approximately $350 per acre for land for the New Sleepy Hollow Park about fifteen miles northeast of Lansing.

Data for the cost of construction of reservoirs was obtained from material prepared by the Corps of Engineers and the Soil Conservation Service.

Costs for planning, overhead, and contingencies were added to the initial and future increments of facility costs. With certain exceptions, these were estimated to be 20 percent of facility costs. Where the total facility costs exceeded 10 million dollars the percentage was reduced to 15; and where the total facility cost was less than one million dollars, the percentage was increased to 25.

Estimates of average annual equivalent costs were calculated from: (1) annual equivalents of interest and amortization on initial development costs (including estimates of costs for planning, overhead and contingencies) based on interest rates of 4 7/8 percent over a period of 100 years, (2) annual equivalents of interest and amortization on the development of future increments of facilities discounted to present worth, (3) annual equivalents of initial costs of operation and maintenance based on 25 cents per visitor day, (see Plate 30), (4) annual equivalents of the cost of operation and maintenance on the addition of future increments of facilities discounted to present worth, (5) annual equivalents of replacement costs on the initial investment, (6) annual equivalents of the replacement costs on future increments of facilities discounted to present worth, (7) annual equivalents of interest and amortization on costs of recreation land, and (8) annual equivalents of interest and amortization on costs of development of reservoirs. See Tables 22 through 27 for a breakdown of average annual equivalent costs for each of the subareas and the basin as a whole.

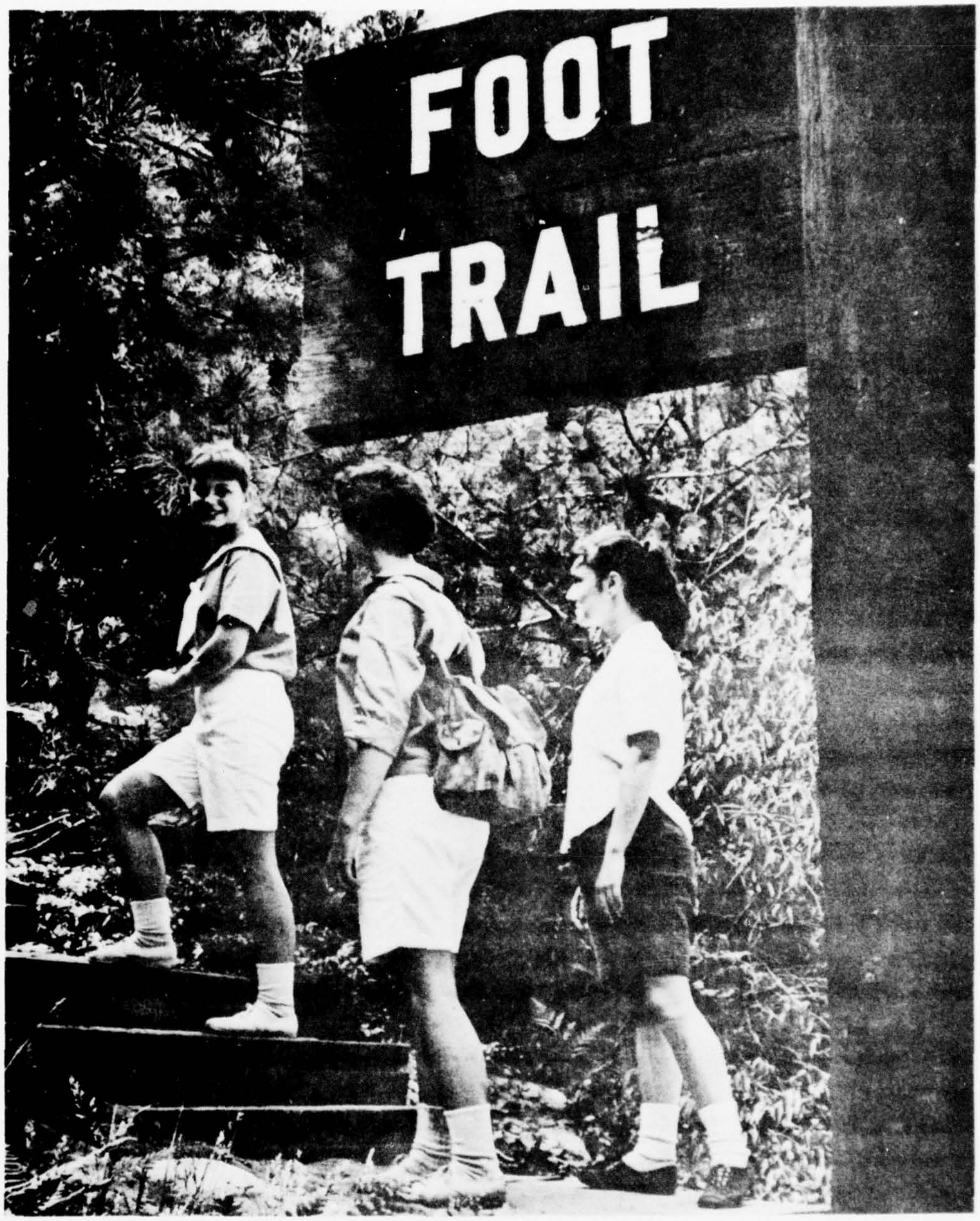

Plate 29--*Hiking can be an interesting adventure full of the unexpected.* (Photo courtesy of Michigan Department of Natural Resources)

Plate 30--*All types of maintenance are required to keep recreational facilities attractive to the public.* (Top photo courtesy of South Bend Tribune; Bottom photo courtesy of Michigan Department of Natural Resources)

Table 22

Estimates of Average Annual
Equivalent Costs for the Proposed
Recreation Development in the Grand River Basin

Elements of Costs		Average Annual Equivalents
Interest and Amortization		
Initial Cost ($36,512,000)	$1,792,000	
Cost of future Increments discounted ($62,418,000)	1,226,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$3,023,000
Operation and Maintenance		
Initial Costs (5,858,000 visits)	1,467,000	
Cost of future increments discounted (9,149,000)	948,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		2,415,000
Major Replacement		
Initial Costs ($36,512,000)	255,000	
Costs of future increments discounted ($62,418,000	172,000	
Total Average Annual Equivalent		
Replacement Costs		427,000
Land Costs ($7,806,000)		385,000
Development of Reservoir costs ($36,479,000)		1,794,000
Total Average Annual Equivalent Costs		$8,044,000

Table 23

Estimates of Average Annual
Equivalent Costs for the Proposed
Recreation Development in the Jackson Subarea

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($5,120,000)	$ 252,000	
Cost of future Increments discounted ($9,374,000)	184,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 436,000
Operation and Maintenance		
Initial Costs (937,000 visits)	235,000	
Cost of future increments discounted (1,389,000 visits)	144,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		379,000
Major Replacement		
Initial Costs ($5,120,000)	36,000	
Costs of future increments discounted ($9,374,000)	26,000	
Total Average Annual Equivalent		
Replacement Costs		62,000
Land Costs ($1,250,000)		61,000
Development of Reservoir costs ($6,858,000)		337,000
Total Average Annual Equivalent Costs		$1,275,000

Table 24

Estimates of Average Annual
Equivalent Costs for the Proposed
Recreation Development in the Lansing Subarea

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($7,847,000)	$ 387,000	
Cost of future Increments discounted ($11,805,000)	231,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 618,000
Operation and Maintenance		
Initial Costs (1,275,000 visits)	319,000	
Cost of future increments discounted (1,918,000 visits)	198,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		517,000
Major Replacement		
Initial Costs ($7,847,000)	55,000	
Costs of future increments discounted ($11,805,000)	33,000	
Total Average Annual Equivalent		
Replacement Costs		88,000
Land Costs ($1,550,000)		77,000
Development of Reservoir costs ($5,663,000)		279,000
Total Average Annual Equivalent Costs		$1,579,000

Table 25

Estimates of Average Annual
Equivalent Costs for the Proposed
Recreation Development in the West Central Subarea

Elements of Costs		Average Annual Equivalents
Interest and Amortization		
Initial Cost ($10,881,000)	$ 535,000	
Cost of future Increments discounted ($13,959,000)	275,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 810,000
Operation and Maintenance		
Initial Costs (1,580,000 visits)	396,000	
Cost of future increments discounted (1,888,000 visits)	196,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		592,000
Major Replacement		
Initial Costs ($10,881,000)	76,000	
Costs of future increments discounted ($13,959,000)	38,000	
Total Average Annual Equivalent		
Replacement Costs		114,000
Land Costs ($1,887,000)		94,000
Development of Reservoir costs (13,491,000)		663,000
Total Average Annual Equivalent Costs		$2,273,000

Table 26

Estimates of Average Annual
Equivalent Costs for the Proposed
Recreation Development in the Grand Rapids Subarea

Elements of Costs		Average Annual Equivalents
Interest and Amortization		
Initial Cost ($8,617,000)	$ 424,000	
Cost of future Increments discounted ($20,331,000)	399,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 823,000
Operation and Maintenance		
Initial Costs (1,460,000 visits)	366,000	
Cost of future increments discounted (2,951,000 visits)	306,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		672,000
Major Replacement		
Initial Costs ($8,617,000)	60,000	
Costs of future increments discounted ($20,311,000)	56,000	
Total Average Annual Equivalent		
Replacement Costs		116,000
Land Costs ($2,362,500)		117,000
Development of Reservoir costs ($9,107,000)		448,000
Total Average Annual Equivalent Costs		$2,176,000

Table 27

Estimates of Average Annual
Equivalent Costs for the Proposed
Recreation Development in the Northeast Subarea

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($4,047,000)	$ 199,000	
Cost of future Increments discounted ($6,969,000)	137,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 336,000
Operation and Maintenance		
Initial Costs (606,000 visits)	151,000	
Cost of future increments discounted (1,003,000 visits)	104,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		255,000
Major Replacement		
Initial Costs ($4,047,000)	28,000	
Costs of future increments discounted ($6,969,000)	19,000	
Total Average Annual Equivalent		
Replacement Costs		47,000
Land Costs ($756,000)		36,000
Development of Reservoir costs ($1,360,000)		67,000
Total Average Annual Equivalent Costs		$ 741,000

21. COST ALLOCATION, COST SHARING, AND REIMBURSEMENT.

a. Cost Allocation. No allocation of costs can be made at this preliminary stage of the study.

b. Least Cost Alternative. No least cost alternative is available at this time. If any particular site is constructed as a multipurpose project, the costs of land and the structure would be prorated among the various uses assigned to the project. Once uses have been specifically assigned to a given site, recreational benefits would need to be determined on the basis of the elevation of the recreation pool in the reservoir, not on the maximum potential of that site. Thus, least cost alternatives cannot be computed until the study has progressed to that point where specific elevations will have been selected for detail study.

c. Cost Sharing and Reimbursement. It would be desirable for non-Federal agencies to share the costs of land and construction with the Federal Government as indicated by Congress in Public Law 89-72.

d. In the Absence of Intent. In the event that the State of Michigan or any other public agency should not desire to participate in sharing the costs at this time it would be desirable for the construction agency to purchase and hold for ten years such lands as may be needed to develop a complete recreation facility.

SECTION VI

VIEWS OF OTHER INTERESTS

This Appendix was reviewed by other participating agencies which offered many helpful suggestions and comments. Most of these comments were of an editorial nature. However, several of them raised substantive points for consideration.

The U. S. Department of Agriculture, commenting on the location of this basin between two major population centers on two large bodies of water, pointed out that the traditional procedures for the estimation of recreational demand may be somewhat biased in favor of the basin by the traditional directional patterns of travel in this State. This point was recognized but, since there is no known data that indicates the magnitude of these directional patterns of travel, no adjustments were attempted.

The Bureau of Sport Fisheries and Wildlife pointed out the need to give adequate consideration to the elements of environmental quality in the development of the recreation plan. They pointed out the need to consider those elements pertaining to the utilization of resources in a manner to either preserve or build environmental quality into recreational and other types of water resource development and to preserve and protect those areas of "high quality, rare, strategic, or other special, natural, cultural, scenic, or archeological features." We believe that these elements have been given adequate consideration.

A draft of the recreation plan was recently reviewed with representatives of the Michigan Department of Natural Resources. They concurred verbally with the plan as it is now proposed. The attached letter sets forth the official views of the department.

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

RALPH A. MAC MULLAN, Director

December 5, 1969

Mr. Roman H. Koenings, Regional Director
Bureau of Outdoor Recreation
3853 Research Park Drive
Ann Arbor, Michigan 48104

Dear Mr. Koenings:

In accordance with your request, we have reviewed the draft of Appendix J, Recreation, Grand River Basin Comprehensive Water Resources Study.

We do not see that there is any conflict with the 1967 Michigan Outdoor Recreation Plan, nor do we foresee conflict with the revised plan now in process of preparation. Both plans present proposals for action. While the two plans may be quite different in character, and not uniform or of the same scope or method as far as analysis of demand, needs, identification of goals, or presentation of specific action measures are concerned, this should not be interpreted as constituting conflict. The existence of variance or difference would not invalidate either plan, but rather would simply broaden the choice of alternatives to be considered by those responsible for arriving at decision on courses of action to be taken. It is the function of plans to present such alternatives.

We are more than satisfied that this draft of Appendix J can constructively serve the intended purpose -- representation of recreation interests in development of an overall plan for the Grand River Basin, as it is being prepared for this Comprehensive Water Resources Study.

Sincerely,

Ralph A. MacMullan

Ralph A. MacMullan
Director

MICHIGAN
THE GREAT LAKE STATE

SECTION VII

CONCLUSIONS

Certain conclusions can be drawn readily from the foregoing projections of demand, supply, needs, and comparisons of benefits and costs.

1. Demand for recreational opportunities, vigorously stimulated by rising incomes and shorter work weeks, will rise at a more rapid rate than the rate of increase of the population.

2. Projections indicate an unsatisfied demand for all water-oriented, outdoor recreation activities in the Grand River Basin for 1980. There is a need for the development of surface water and adjacent recreational lands to meet this growing demand.

3. As a result of the widening gap between demand and supply, the unsatisfied demand of most of the five water-oriented activities considered will continue to increase.

4. The greatest supply shortage involves resources and facilities necessary for water-dependent activities, such as boating, water skiing, and swimming.

5. The need for land for recreational development will continue to rise rapidly.

6. The area of greatest need encircles the Lansing and Northeast populations. There is an acute shortage of usable water and recreation lands in the tri-county Lansing Subarea and the two counties that comprise the Northeast Subarea.

7. The unsatisfied demand originating from other population centers within the basin is not as severe as that in the Lansing area, but demand projections demonstrate a growing need for access to day-use facilities within a short driving radius from each SMSA.

8. Many of the 79 sites proposed by the Corps of Engineers and the Soil Conservation service have limited value for recreational development because of flat land adjacent to proposed shorelines, exposure of extensive mud flats if any drawdown should occur, and very steep banks adjacent to shorelines.

9. Many of the 132 sites proposed by the Soil Conservation Service, exclusive of those that duplicate the Corps of Engineer sites, would be of modest size and could contribute very substantially to the satisfaction of demand for all activities except powerboating and water skiing.

10. It is unlikely that adequate recreation facilities can be developed to meet the demands for recreation in 1985. However, additional supplies should be developed as rapidly as practical to provide local people with the opportunity to participate in many recreational activities near their homes.

11. A substantial number of existing lakes have substantial potential for the development of certain recreational facilities to meet a part of the growing needs in the basin. Likewise, portions of the larger streams hold potential for such development. The potential of these resources should be explored and utilized to their fullest capacity.

12. According to projections of demand for water-based recreational facilities, it appears to be physically impossible for the Corps of Engineers and the Soil Conservation Service to develop a sufficient area of surface water for motorboating and water skiing, together with all other needs for water, within the watershed boundaries. If this demand develops as projected, recreators will have to seek other locations out of the basin to satisfy their demands or other kinds of recreational opportunities to satisfy their desires.

13. The Detroit and Toledo SMSA's are located on relatively flat lake plain relief which has very limited recreational opportunities. Much of the population distributed over these flat areas by the straight percentage apportionment method used in this study actually seeks to satisfy their recreational needs in areas of undulating to rolling relief, such as that found in the Jackson Subarea and similar nearby areas. Therefore, the validity of the effective population figures for the Jackson Subarea is in question, and the figures are probably too low. Thus, the surplus shown for this Subarea could easily not occur.

14. The Northeast Subarea generates only limited demands within its borders, but it receives large demands from the SMSA's to the northeast, east, and southwest. Moreover, these demands are intensified by the lack of useable facilities along the shores of Saginaw Bay which has a pollution problem and has a very limited extent of natural beaches within 35 miles to 40 miles of these population centers.

15. The proposed recreation plan could satisfy a very substantial part of the needs projected to exist in the Basin by 1985.

16. The resource developments set forth in the outdoor recreation plan for this basin are considered to be reasonable proposals to provide as much opportunity for a variety of water-oriented outdoor recreation activities as possible, consistent with the capability of the resources and the needs identified in this report.

17. The preservation of outstanding resources could help to provide recreational opportunities to the public.

18. The restoration and/or maintenance of the quality of water in lakes and streams in the Grand River Valley is vitally necessary to provide as much opportunity as possible for water-based activities and for the enhancement of other activities.

19. There is an urgent need for research in the determination and projection of recreation demand, both as to origin and as to direction of travel from that point of origin, to better enable us to predict future patterns of recreation demand in specific areas.

20. The required scale of recreation development needed to satisfy present and future demands makes coordination between local, State, and Federal agencies both desirable and necessary.

21. This recreation plan is in accord with the Michigan Outdoor Recreation Plan.

22. The private sector needs to be encouraged to provide a substantial portion of recreation facilities in those activities where it can function effectively and profitably. The State should take whatever steps that are necessary to encourage greater participation by the private sector in the development of recreational opportunities.

23. Several State parks in and near the Basin have additional potential for development. There is an excellent opportunity to develop a trail system along the Grand River Valley from the proposed Sandstone Creek Reservoir to Lake Michigan. This trail could tie in with the proposed North Country National Scenic Trail along the Lake Michigan shore and could be extended through the Huron River Valley to the Detroit metropolitan area.

The Coldwater and Flat Rivers have scenic qualities worthy of preservation as scenic or recreational rivers at the State level.

SECTION VIII

RECOMMENDATIONS

We recommend that:

1. The outdoor recreation plan set forth in this appendix be integrated into the Basin Plan to be presented in Appendix Q.

2. Access to and adequate abutting land on all suitable existing lakes and river segments, not now available for public use, be acquired and developed for public use.

3. The State parks listed in the recreation plan be developed to their ultimate capacity as soon as possible.

4. First consideration be given to the development of the proposed Sandstone Creek, Doan Creek, Bear Creek, and the Lookingglass-Grub Creek recreation areas in the Jackson, Lansing, and Northeast Subareas to meet the need of the Lansing and Northeast Subareas.

5. The State of Michigan and local governments take all necessary steps to implement the valley preserve system along the Grand River Valley as soon as possible.

6. The private sector be strongly encouraged to provide additional recreational opportunities to the public and that local and State governments provide all due assistance toward this end.

7. A trail system be developed along the Grand River Valley to tie into the proposed North Country National Trail on the Lake Michigan Shore and that this system be extended into the Detroit metropolitan area through the Huron River Valley.

8. Consideration be given to preservation of the Coldwater and Flat Rivers in their natural, free-flowing condition for the enjoyment of the public as State scenic or recreational rivers.

9. Areas of historic, archeological, or ecological significance identified as worthy of preservation be protected from development not consistent with their existing character.

10. The quality of water in the streams, lakes, and reservoirs be maintained at a level suitable for recreation.

11. The local, State, and Federal agencies work cooperatively to develop the recreation resources of the Grand River Basin.

8. Consideration be given to preservation of the Coldwater and Flat Rivers in their natural, free-flowing condition for the enjoyment of the public as State scenic or recreational rivers.

9. Areas of historic, archeological, or ecological significance identified as worthy of preservation be protected from development not consistent with their existing character.

10. The quality of water in the streams, lakes, and reservoirs be maintained at a level suitable for recreation.

11. The local, State, and Federal agencies work cooperatively to develop the recreation resources of the Grand River Basin.

APPENDIX A

Methodology for Determination of Projected Effective Population

Effective population consists of that population which is 12 years of age or over and which may be expected to contribute toward demand in the Grand River Basin. All population figures were reduced to an effective population figure for the purpose of developing projections of demand. The development of effective population figures by subarea was derived by the following steps.

1. The five basic subareas were defined as Jackson, composed entirely of Jackson County; Lansing, which includes all of Clinton, Eaton, and Ingham Counties; West Central, which is composed of Barry, Ionia, and Montcalm Counties; Grand Rapids, consisting of Kent and Ottawa Counties; and Northeast, made up of Gratiot and Shiawasee Counties. These delineations coincide with the subarea boundaries used in the Economic Base Studies for the basin.

2. Circles with radii of 40 and 125 miles were drawn from the center of population of each SMSA either lying in the basin or located within 125 miles of the basin boundary. Circles with a radius of 40 miles also were drawn either from the center of the principal city within, or from the geographic center of each non-SMSA county lying within the basin boundary, and each county outside the basin boundary, but within 40 miles of it. For this discussion these circles were designated as the recreation service areas of their respective centers of population.

For the purposes of this distribution, it was assumed that the population of each SMSA is concentrated at the center of the principal city of each SMSA with certain exceptions. The center of the population of the Detroit SMSA was assumed to be about eight miles northwest of the downtown center of the city, and the center of the Chicago SMSA about seven miles west of the center of that city. The population of non-SMSA counties was assumed to be concentrated at the center of the principal city located in that county or, where no city dominated the population, at the geographic center of that county.

It also was assumed that people would radiate equally in all directions from each center of concentration. In actuality, it is known that this premise contains certain weaknesses because some areas possess greater opportunities for development of recreational facilities than others. However, this difference in opportunity or potential opportunity among various areas cannot be measured with any degree of precision and, therefore, becomes a nebulous condition which is recognized, but it is one for which no adjustments were attempted. An example is the difference in opportunity for recreational pur-

suits on the lake plain area around Detroit versus the morainic uplands of Jackson, Washtenaw, and other counties. The flat lake plain is much less attractive than the hilly uplands in parts of Jackson and Washtenaw Counties.

3. The segment of each recreation service area lying within the basin boundary was planimetered by subarea to determine the percentage of that recreation service area lying within each of the subareas.

4. The population of each SMSA and non-SMSA county within the basin and each SMSA within 125 miles of the basin boundary and each non-SMSA county within 40 miles of the basin boundary was taken from 1960 census data and adjusted to include all persons 12 years of age and over only. The population, 12 years of age and over, was then multiplied by 60 and 30 percent, respectively, to obtain the number of those persons contributing to day-use activities and overnight or weekend use activities. Thus, the day-use and weekend-use segments of the in-basin populations were distributed equally within the limits of the respective circles, both within and outside of the basin and subarea boundaries. Likewise, populations outside of, but within either 40 or 125 miles of basin boundary, were distributed uniformly within the limits of the respective day-use or weekend-use circles. The remaining 10 percent of the population was assumed to include those persons on extended vacations and were not considered in this study.

5. The day-use population figure of each source of effective population to that subarea was then multiplied by the percent figure of each respective recreation service area to obtain the amount of effective population to be alloted to each subarea from that source. Likewise, the overnight population from each source was allocated on the basis of respective percentages to each of the subareas.

6. Where more than 10 percent of the area of a recreation service area radiating around any given source of population lay over large bodies of water or across international boundaries, proportionate adjustments were made to redistribute the population falling in such areas evenly over the remainder of the recreation service area. In this analysis the redistribution of population falling over Canadian land resulted in an increase of less then three percent in effective population for the basin, with increases ranging from less than one percent in the Grand Rapids Subarea to nearly four percent in the Lansing Subarea.

7. The total of the adjusted effective populations orginating from each of the recreation service areas is the effective population for each subarea.

APPENDIX B

Methodology
Participation Rates

The participation rates used to develop the demand and needs section of this study were developed from data published in ORRRC Reports 19 and 26. The basic data was expanded for the years 1980, 2000, and 2020 and adjusted for specific factors within the Grand River Basin. These figures were derived by the following method.

1. The actual figure for population, 12 years of age and over (called effective population) for 1960 and the projected figures for effective population for the years 1976 and 2000 were graphed to obtain figures for projections of effective population for the years of 1980 and 2020. The figures for effective population for 1960, 1976, and 2000 were obtained from the table on page 17 of ORRRC Report No. 26. A straight line projection was used in the development of the graph beyond the year 2000.

2. The actual figures for numbers of occasions (with opportunity) expected to occur during the months of June through August for the years of 1960, 1976, and 2000 were graphed for the eight selected activities--swimming, boating, water-skiing, camping, picnicking, sightseeing, nature walks, and hiking--to obtain the estimated number of occasions for the years of 1980 and 2020. The figures used to make the projections were obtained from Table 6, page 22, ORRRC Report No. 26. A straight line projection was used beyond the year of 2000.

3. The number of occasions for each activity for each year of projection was divided by the respective figure for projected effective population to obtain a raw rate of participation on a per capita basis for the three summer months for the United States.

4. Regional summer participation rates for each activity in each year of projection were developed from the derived United States summer rates by proportionment between the United States and north central regional summer participation rates for 1960. The 1960 United States and regional summer rates were obtained from Table 1.01, page 120, ORRRC Report No. 19.

5. Regional annual participation rates for each activity in each year of projection were derived from the respective regional summer rates by proportionment between the 1960 north central summer and annual rates given in Tables 1.01, 2.01, 3.01, and 4.01, ORRRC Report No. 19.

6. Both the annual and summer projected rates were adjusted upward by four percent for the above average income received in the Grand River Basin.

If the new 1965 participation rates developed by the Bureau of Outdoor Recreation had been used, demands by activity would be from 11 to 88 percent higher than those stated in this report. Percentage increases are as follows: swimming - 19% boating - 20%; water-skiing - 88%; camping - 47%; picnicking - 41 %; sightseeing - 11%; nature walks - 34%; and hiking - 27%.

APPENDIX C

Methodology for Determination of Number of Peak Days

The number of peak days is needed to calculate a design load from the total number of projected summer occasions for any given activity. To determine the number of peak days requires the establishment of several assumptions. The following procedure was used.

1. The summer recreation season was assumed to span a period of 14 weeks extending from Memorial Day through the Labor Day weekend for an average length of 98 days.

2. Data developed on Corps of Engineers reservoirs in Indiana and Kentucky revealed that nearly 50 percent of all attendance took place on Sunday, about 14 percent on Saturday, and the remainder was divided nearly equally among the other five days.

3. Therefore, the 14 Sundays and three holidays were assumed to represent an average peak day. It was assumed that three weekdays would be equivalent to one peak day; therefore, the 81 remaining days would equal 27 peak days for a total of 44 peak days.

4. However, an adjustment must be made for adverse weather conditions. It was assumed that 20 percent, or nine, of the gross number of peak days would be lost because of this factor, thus a net of 35 peak days remained for use in the calculation of design loads.

APPENDIX D

Methodology for Determination of Demands and Needs

The determination of demands and needs for each of the subareas and the basin as a whole was developed from the effective population for each area and the respective summer participation rate for each activity for each of the years of projection by the following steps.

1. The effective population was first multiplied by the summer participation rates for the respective years of projection to obtain the total number of summer occasions for each of the five selected water-oriented activities.

2. The total number of summer occasions for each activity was then divided by the product of the number of peak days and the turnover factor * for that activity to obtain a design load, the number of people that would need to be accommodated in any given activity at any one time.

3. The design load for each activity (by each year of projection) was divided by the number of people that can be accommodated on an acre of land developed completely for that specific use to obtain the total acres of land needed at any one time for a given activity. This is total demand by activity and by year for each subarea and the basin as a whole.

4. Needs for each subarea and the basin as a whole were determined by subtracting existing supply in acres (adjusted according to intensity of present use) and programmed supply (plans drawn and programmed for construction) for each activity from the demand for each activity by each year of projection. The remainder is the need for developed land by activity.

5. The developed land represents between 10 and 20 percent of the total land needed for the development of all recreational activities. The 80 to 90 percent of undeveloped land would function as buffer between activities and as open space for trails, sightseeing, etc.

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*Turnover factor is defined as the number of times that any one facility will be used during any one day.

APPENDIX E

SUPPLEMENTARY STATISTICAL TABLES

The following tables provide estimates of demand by activity for each subarea.

The following tables provide estimates of needs by activity for each subarea.

The following tables provide detailed estimates of costs by project for each subarea.

The following tables provide estimates of visitation and average annual equivalent benefits by proposed projects.

The following tables provide estimates of average annual equivalent costs by proposed project by subarea.

Table 28

SUMMARY OF DEMAND REQUIREMENTS

FOR JACKSON SUBAREA

Activity	Year	Annual Occasions (1,000's)	Summer Occasions (1,000's)	Design Load Visits (1,000's)	Developed Acreage Requirements: Land: Activities	Developed Acreage Requirements: Land: Parking	Developed Acreage Requirements: Water (1,000's)
Swimming	1960	353	306	4.3	10	13	
	1980	769	667	9.6	22	27	
	2000	1,396	1,210	17.3	40	50	
	2020	2,175	1,892	28.0	62	77	
Boating	1960	193	127	1.5		15	3.0
	1980	429	282	3.2		32	6.4
	2000	796	524	6.0		60	12.0
	2020	1,236	814	9.3		93	18.6
Water Skiing	1960	21	17	.1		1	.8
	1980	60	47	.2		2	1.6
	2000	123	95	.5		5	4.0
	2020	199	155	.7		7	5.6
Camping	1960	65	40	1.1	29		
	1980	189	115	3.3	81		
	2000	414	253	7.3	181		
	2020	701	433	12.4	310		
Picnicking	1960	361	233	3.4	68	10	
	1980	665	428	6.1	123	17	
	2000	1,101	709	10.1	203	29	
	2020	1,668	1,070	15.3	305	44	
Secondary Activities	1960	934	349			7	
	1980	2,138	833			13	
	2000	4,021	1,566			23	
	2020	6,491	2,536			36	
Summary of all Activities	1960	1,927	1,072	10.4	107	46	3.8
	1980	4,250	2,372	22.4	226	91	8.0
	2000	7,851	4,357	41.2	424	167	16.0
	2020	12,470	6,900	65.7	677	257	24.2

Table 29

SUMMARY OF DEMAND REQUIREMENTS

FOR LANSING SUBAREA

Activity	Year	Annual Occasions (1,000's)	Summer Occasions (1,000's)	Design Load Visits (1,000's)	Developed Acreage Requirements: Land: Activities	Land: Parking	Water (1,000's)
Swimming	1960	817	709	10.6	24	29	
	1980	1,780	1,543	22.1	51	63	
	2000	3,232	2,801	40.3	91	114	
	2020	5,037	4,382	62.1	144	179	
Boating	1960	447	293	3.3		33	6.6
	1980	994	654	7.5		75	15.0
	2000	1,842	1,213	13.9		139	27.8
	2020	2,861	1,884	21.5		215	43.0
Water Skiing	1960	49	39	.2		2	1.6
	1980	138	109	.5		5	4.0
	2000	283	219	1.0		10	8.0
	2020	461	358	1.7		17	13.6
Camping	1960	150	93	2.6	65		
	1980	438	268	7.6	191		
	2000	956	585	16.8	419		
	2020	1,623	1,000	28.6	715		
Picnicking	1960	838	536	7.6	153	21	
	1980	1,540	991	14.1	283	40	
	2000	2,550	1,640	23.4	468	66	
	2020	3,863	2,478	35.4	708	101	
Secondary Activities	1960	2,163	809			14	
	1980	4,950	1,930			29	
	2000	9,313	3,623			54	
	2020	15,035	5,875			85	
Summary of all Activities	1960	4,464	2,479	24.3	242	99	8.2
	1980	9,840	5,495	51.8	525	212	19.0
	2000	18,187	10,081	95.4	978	383	35.8
	2020	28,880	15,977	149.3	1,567	597	56.6

Table 30

SUMMARY OF DEMAND REQUIREMENTS

FOR WEST CENTRAL SUBAREA

Activity	Year	Annual Occasions (1,000's)	Summer Occasions (1,000's)	Design Load Visits (1,000's)	Developed Acreage Requirements — Land: Activities	Developed Acreage Requirements — Land: Parking	Developed Acreage Requirements — Water (1,000's)
Swimming	1960	891	772	11.1	26	32	
	1980	1,943	1,684	24.1	55	70	
	2000	3,523	3,056	43.7	101	125	
	2020	5,492	4,779	68.1	157	195	
Boating	1960	488	320	3.7		37	7.4
	1980	1,085	713	8.1		81	16.2
	2000	2,009	1,323	15.1		151	30.2
	2020	3,121	2,055	23.5		235	47.0
Water Skiing	1960	54	42	.2		2	1.6
	1980	151	119	.6		6	4.8
	2000	309	238	1.1		11	8.8
	2020	502	391	1.9		19	15.2
Camping	1960	164	101	2.9	73		
	1980	478	291	8.4	210		
	2000	1,044	639	18.3	456		
	2020	1,770	1,091	31.1	778		
Picnicking	1960	913	585	8.4	168	24	
	1980	1,680	1,081	15.5	310	44	
	2000	2,781	1,788	25.6	513	74	
	2020	4,211	2,701	38.6	773	110	
Secondary Activities	1960	2,359	880			15	
	1980	5,400	2,105			31	
	2000	10,156	3,950			58	
	2020	16,395	6,405			93	
Summary of all Activities	1960	4,869	2,700	26.3	267	110	9.0
	1980	10,737	5,993	56.7	575	232	21.0
	2000	19,826	10,994	103.8	1,070	419	39.0
	2020	31,491	17,422	163.2	1,707	652	62.2

Table 31

SUMMARY OF DEMAND REQUIREMENTS

FOR GRAND RAPIDS SUBAREA

Activity	Year	Annual Occasions (1,000's)	Summer Occasions (1,000's)	Design Load Visits (1,000's)	Developed Acreage Requirements - Land: Activities	Land: Parking	Water (1,000's)
Swimming	1960	670	581	8.4	20	24	
	1980	1,461	1,266	18.1	42	52	
	2000	2,650	2,297	32.9	76	94	
	2020	4,130	3,592	51.4	119	147	
Boating	1960	367	240	2.7		27	5.4
	1980	816	536	6.2		62	12.4
	2000	1,510	995	11.4		114	22.8
	2020	2,346	1,545	17.7		177	35.4
Water-Skiing	1960	41	32	.2		2	1.6
	1980	114	90	.4		4	3.2
	2000	233	179	.9		9	7.2
	2020	378	294	1.4		14	11.2
Camping	1960	124	76	2.2	56		
	1980	359	219	6.2	156		
	2000	785	480	13.8	344		
	2020	1,330	820	23.4	585		
Picnicking	1960	686	440	6.2	125	18	
	1980	1,264	813	11.6	233	34	
	2000	2,091	1,345	19.3	385	55	
	2020	3,166	2,031	29.0	580	82	
Secondary Activities	1960	1,773	664			10	
	1980	4,061	1,584			24	
	2000	7,635	2,969			44	
	2020	12,329	4,818			70	
Summary of All Activities	1960	3,661	2,033	19.7	201	81	7.0
	1980	8,075	4,508	42.5	431	176	15.6
	2000	14,904	8,265	78.3	805	316	30.0
	2020	23,679	13,100	122.9	1,284	490	46.6

Table 32

SUMMARY OF DEMAND REQUIREMENTS
FOR NORTHEAST SUBAREA

Activity	Year	Occasions (1,000's)	Occasions (1,000's)	Design Load Visits (1,000's)	Developed Acreage Requirements: Land Activities	Land Parking	Water (1,000's)
Swimming	1960	607	527	7.6	18	22	
	1980	1,324	1,149	16.4	37	48	
	2000	2,403	2,084	29.9	69	86	
	2020	3,724	3,259	46.6	107	134	
Boating	1960	332	218	2.5		25	5.0
	1980	739	487	5.6		56	11.2
	2000	1,370	902	10.3		103	20.6
	2020	2,128	1,401	16.0		160	32.0
Water Skiing	1960	37	29	.1		1	.8
	1980	103	82	.4		4	3.2
	2000	211	163	.8		8	6.4
	2020	342	266	1.3		13	10.4
Camping	1960	111	69	2.0	50		
	1980	325	199	5.6	140		
	2000	711	435	12.4	310		
	2020	1,206	744	21.3	531		
Picnicking	1960	623	399	5.8	115	16	
	1980	1,146	736	10.5	210	31	
	2000	1,896	1,220	17.5	350	51	
	2020	2,871	1,843	26.3	525	76	
Secondary Activities	1960	1,608	603			9	
	1980	3,681	1,435			21	
	2000	6,924	2,694			41	
	2020	11,180	4,369			64	
Summary of All Activities	1960	3,318	1,845	18.0	183	75	5.8
	1980	7,318	4,088	38.5	387	160	14.4
	2000	13,515	7,498	70.9	729	289	27.0
	2020	21,451	11,882	111.5	1,163	447	42.4

Table 33

PROJECTED NEED FOR JACKSON SUBAREA

Activity	Year	Demand in Acres: Developed Land	Demand in Acres: Water Surface (1,000's)	Supply in Acres: Developed Land A.*	Supply in Acres: Developed Land B.**	Supply in Acres: Water Surface (1,000's) A.*	Supply in Acres: Water Surface (1,000's) B.**	Need in Acres: Developed Land	Need in Acres: Water Surface (1,000's)
Swim-	1960	10		12				(2)	
ming	1980	22			0			10***	
	2000	40						28	
	2020	62						50	
Boating	1960	16	3.8	9		7.4		7	----
and	1980	34	8.0		2		0	23	.6
Water	2000	65	16.0					54	8.6
Skiing	2020	100	24.2					89	16.8
Camping	1960	29		78				(49)******	
	1980	81			21			(18)	
	2000	181						82	
	2020	310						211	
Picnick-	1960	68		88				(20)	
ing	1980	123			31			4	
	2000	203						84	
	2020	305						186	
Parking	1960	30		32				(2)	
	1980	57			0			37****	
	2000	102						70	
	2020	157						125	
Summary	1960	153	3.8	219				7*****	---
of above	1980	317	8.0		54			62	.6
Activi-	2000	591	16.0					318	8.6
ties	2020	934	24.2					661	16.8

* Existing developed land; ** Land programmed for development before 1980.

*** The area of water surface projected to satisfy needs for boating and water skiing will provide the small amount of water surface needed for swimming.

**** Land for parking includes that needed for all parking except boating, water skiing and camping which is included in land needed for the activity.

***** Total needs cannot be accurately obtained by subtracting total supply from total demand because surpluses of facilities in one activity cannot be used to offset a need in another

****** Indicates surpluses.

Table 34

PROJECTED NEED FOR LANSING SUBAREA

Activity	Year	Demand in Acres: Developed Land	Demand in Acres: Water Surface (1,000's)	Supply in Acres: Developed Land A.*	Supply in Acres: Developed Land B.**	Supply in Acres: Water Surface (1,000's) A.*	Supply in Acres: Water Surface (1,000's) B.**	Need in Acres: Developed Land	Need in Acres: Water Surface (1,000's)
Swimming	1960	24		0				24***	
	1980	51			6			45	
	2000	91						85	
	2020	144						138	
Boating and Water Skiing	1960	35	8.2	3		1.5		32	6.7
	1980	80	19.0		5		.4	72	17.1
	2000	149	35.8					141	33.9
	2020	232	56.6					224	54.7
Camping	1960	65		12				53	
	1980	191			26			153	
	2000	419						381	
	2020	715						677	
Picnicking	1960	153		70				83	
	1980	283			61			152	
	2000	468						337	
	2020	708						577	
Parking	1960	64		7				57****	
	1980	132			18			107	
	2000	234						209	
	2020	365						340	
Summary of above Activities	1960	341	8.2	92				248*****	6.7
	1980	737	19.0		116			529	17.1
	2000	1,361	35.8					1,153	33.9
	2020	2,164	56.6					1,956	54.7

* Existing developed land; ** Land programmed for development before 1980.

*** The area of water surface projected to satisfy needs for boating and water skiing will provide the small amount of water surface needed for swimming.

**** Land for parking includes that needed for all parking except boating, water skiing and camping which is included in land needed for the activity.

***** Total needs cannot be accurately obtained by subtracting total supply from total demand because surpluses of facilities in one activity cannot be used to offset a need in another.

Table 35

PROJECTED NEED FOR WEST CENTRAL SUBAREA

Activity	Year	Demand in Acres: Developed Land	Demand in Acres: Water Surface (1,000's)	Supply in Acres: Developed Land A.*	Supply in Acres: Developed Land B.**	Supply in Acres: Water Surface (1,000's) A.*	Supply in Acres: Water Surface (1,000's) B.**	Need in Acres: Developed Land	Need in Acres: Water Surface (1,000's)
Swimming	1960	26		27				(1)******	
	1980	55			7			21***	
	2000	101						67	
	2020	157						123	
Boating and Water Skiing	1960	39	9.0	25		18.0		14	----
	1980	87	21.0		3		.1	59	2.9
	2000	162	39.0					134	20.9
	2020	254	62.2					226	44.1
Camping	1960	73		42				31	
	1980	210			45			123	
	2000	456						369	
	2020	778						691	
Picnicking	1960	168		88				80	
	1980	310			50			172	
	2000	513						375	
	2020	773						635	
Parking	1960	71		70				1****	
	1980	145			20			55	
	2000	257						167	
	2020	398						308	
Summary of above Activities	1960	377	9.0					126*****	----
	1980	807	21.0					430	2.9
	2000	1,489	39.0					1,112	20.9
	2020	2,360	62.2					1,983	44.1

* Existing developed land; ** Land programmed for development before 1980.

*** The area of water surface projected to satisfy needs for boating and water skiing will provide the small amount of water surface needed for swimming.

**** Land for parking includes that needed for all parking except boating, water skiing and camping which is included in land needed for the activity.

***** Total needs cannot be accurately obtained by subtracting total supply from total demand because surpluses of facilities in one activity cannot be used to offset a need in another.

****** Indicates surpluses.

Table 36

PROJECTED NEED FOR GRAND RAPIDS SUBAREA

Activity	Year	Demand in Acres: Developed Land	Demand in Acres: Water Surface (1,000's)	Supply in Acres: Developed Land A.*	Supply in Acres: Developed Land B.**	Supply in Acres: Water Surface (1,000's) A.*	Supply in Acres: Water Surface (1,000's) B.**	Need in Acres: Developed Land	Need in Acres: Water Surface (1,000's)
Swimming	1960	20		28				(8)******	
	1980	42			9			5***	
	2000	76						39	
	2020	119						82	
Boating and Water Skiing	1960	29	7.0	5		11.1		24	----
	1980	66	15.6		7		0	54	4.5
	2000	123	30.0					111	18.9
	2020	191	46.6					179	35.5
Camping	1960	56		51				5	
	1980	156			54			51	
	2000	344						239	
	2020	585						480	
Picnicking	1960	125		209				(84)	
	1980	233			68			(44)	
	2000	385						108	
	2020	580						303	
Parking	1960	52		35				17****	
	1980	110			25			50	
	2000	193						133	
	2020	299						239	
Summary of above Activities	1960	282	7.0					46*****	--
	1980	607	15.6					160	4.5
	2000	1,121	30.0					630	18.9
	2020	1,774	46.6					1,283	35.5

* Existing developed land; **Land programmed for development before 1980.

***The area of water surface projected to satisfy needs for boating and water skiing will provide the small amount of water surface needed for swimming.

****Land for parking includes that needed for all parking except boating, water skiing, and camping which is included in land needed for the activity.

*****Total needs cannot be accurately obtained by subtracting total supply from total demand because surpluses of facilities in one activity cannot be used to offset a need in another.

******Indicates surpluses.

Table 37

PROJECTED NEED FOR NORTHEAST SUBAREA

Activity	Year	Demand in Acres: Developed Land	Demand in Acres: Water Surface (1,000's)	Supply in Acres: Developed Land A.*	Supply in Acres: Developed Land B.**	Supply in Acres: Water Surface (1,000's) A.*	Supply in Acres: Water Surface (1,000's) B.**	Need in Acres: Developed Land	Need in Acres: Water Surface (1,000's)
Swimming	1960	18		0				18***	
	1980	37			0			37	
	2000	69						69	
	2020	107						107	
Boating and Water Skiing	1960	26	5.8	1		1.0		25	4.8
	1980	60	14.4		0		0	59	13.4
	2000	111	27.0					110	26.0
	2020	173	42.4					172	41.4
Camping	1960	50		0				50	
	1980	140			0			140	
	2000	310						310	
	2020	531						531	
Picnicking	1960	115		5				110	
	1980	210			2			203	
	2000	350						343	
	2020	525						518	
Parking	1960	47		1				46****	
	1980	100			0			99	
	2000	178						177	
	2020	274						273	
Summary of above Activities	1960	256	5.8					249*****	4.8
	1980	547	14.4					538	13.4
	2000	1,018	27.0					1,009	26.0
	2020	1,610	42.4					1,601	41.4

* Existing developed land; **Land programmed for development before 1980.

***The area of water surface projected to satisfy needs for boating and water skiing will provide the small amount of water surface needed for swimming.

****Land for parking includes that needed for all parking except boating, water skiing and camping which is included in land needed for the activity.

*****Total needs cannot be accurately obtained by subtracting total supply from total demand because surpluses of facilities in one activity cannot be used to offset a need in another

Table 38

Summary of Costs by Type of Development
for the Jackson Subarea

Activity and Related Needs	Cost per Standard Unit	Sandstone Creek Reservoir: No. of Standard Units	Sandstone Creek Reservoir: Cost of Facilities (000)	Waterloo Recreation Area: No.of Standard Units	Waterloo Recreation Area: Cost of Facilities (000)	Total for Subarea: Standard Unit	Total for Subarea: Cost (000)
Swimming	146,000	17.40	2,540	--	--	17.40	2,540
Boating & Skiing	205,000	2.90	595	--	--	2.90	595
Camping	360,000	8.00	2,880	.32	115	8.32	2,995
Picnicking	142,000	9.00	1,278	.50	71	9.50	1,349
Sightseeing	85,000	1.87	159	.04	3	1.91	162
Nature Walks	93,000	2.31	215	.05	5	2.36	220
Hiking	90,000	.86	77	.02	2	.88	79
Signs	250	42.30	11	.93	--	43.23	11
Landscaping	1,500	42.30	63	.93	1	43.23	64
Admin. Bldg.	6,000	42.30	233	.93	6	43.23	239
Roads	40,000	42.30	1,692	.93	37	43.23	1,729
Sewage Plant	60,000	42.30	2,538	.93	56	43.23	2,594
Total			12,281		296		12,577
Initial Increment			4,130		296		4,426
Future Increment			8,151		000		8,151

Table 39

Summary of Costs by Type of Development
for Lansing Subarea

Activity and Related Needs	Cost per Standard Unit	Doan Creek Reservoir No. of Standard Units	Doan Creek Reservoir Cost of Facilities (000)	Portland Reservoir No. of Standard Units	Portland Reservoir Cost of Facilities (000)	No Name Reservoir No. of Standard Units	No Name Reservoir Cost of Facilities (000)
Swimming	146,000	6.53	953	8.70	1,270	4.35	635
Boating & Skiing	205,000	1.02	209	.53	107	.45	92
Camping	360,000	2.40	864	4.80	1,728	2.00	720
Picnicking	142,000	4.00	568	5.00	710	3.00	426
Sightseeing	85,000	.73	62	.92	78	.49	42
Nature Walks	93,000	.90	84	1.14	106	.61	57
Hiking	90,000	.34	31	.43	39	.23	21
Signs	250	15.92	4	21.51	5	9.80	2
Landscaping	1,500	15.92	24	21.51	32	9.80	15
Admin. Bldg.	6,000	15.92	96	21.51	129	9.80	59
Roads	40,000	15.92	636	21.51	860	9.80	392
Sewage Plant	60,000	15.92	954	21.51	1,291	9.80	590
Total Cost			4,485		6,355		3,051
Initial Increment			1,503		2,031		1,298
Future Increment			2,982		4,324		1,753

Table 39 (con't)

Summary of Costs by Type of Development
for Lansing Subarea

Activity and Related Needs	Cost per Standard Unit (000)	Sleepy Hollow State Park No. of Standard Units	Sleepy Hollow State Park Cost of Facilities (000)	Lansing Valley Preserve No. of Standard Units	Lansing Valley Preserve Cost of Facilities (000)	Total for Subarea Standard Unit	Total for Subarea Cost (000)
Swimming	146,000	1.74	254	.87	127	22.19	3,239
Boating & Skiing	205,000	--	--	--	--	2.18	408
Camping	360,000	.48	173	.20	72	9.88	3,557
Picnicking	142,000	3.00	426	2.00	284	17.00	2,414
Sightseeing	85,000	.28	24	.17	15	2.59	221
Nature Walks	93,000	.35	33	.21	20	3.21	300
Hiking	90,000	.13	12	.08	7	1.21	110
Signs	250	6.00	2	3.53	1	56.76	14
Landscaping	1,500	6.00	9	3.53	5	56.76	85
Admin. Bldg.	6,000	6.00	36	3.53	21	56.76	341
Roads	40,000	6.00	240	3.53	141	56.76	2,269
Sewage Plant	60,000	6.00	360	3.53	212	56.76	3,407
Total Cost			1,569		905		16,365
Initial Increment			520		132		5,484
Future Increment			1,049		773		10,881

Table 40

Summary of Costs by Type of Development
for West Central Subarea

Activity and Related Needs	Cost per Standard Unit	Prairie Creek Reservoir No. of Standard Units	Prairie Creek Reservoir Cost of Facilities (000)	Duck Creek Reservoir No. of Standard Units	Duck Creek Reservoir Cost of Facilities (000)	Fish Creek Reservoir No. of Standard Units	Fish Creek Reservoir Cost of Facilities (000)
Swimming	146,000	6.53	953	4.35	635	6.53	953
Boating & Skiing	205,000	.46	93	.35	72	1.20	247
Camping	360,000	4.80	1,728	4.00	1,440	7.20	2,592
Picnicking	142,000	4.00	568	4.00	568	5.00	710
Sightseeing	85,000	.75	64	.62	53	.95	81
Nature Walks	93,000	.93	86	.76	71	1.18	110
Hiking	90,000	.35	32	.28	25	.44	40
Signs	250	17.80	4	14.36	4	22.50	6
Landscaping	1,500	17.80	27	14.36	22	22.50	34
Admin. Bldg.	6,000	17.80	107	14.36	86	22.50	135
Roads	40,000	17.80	712	14.36	574	22.50	900
Sewage Plant	60,000	17.80	1,068	14.36	862	22.50	1,350
Total Cost			5,442		4,412		7,158
Initial Increment			1,821		1,657		1,901
Future Increment			3,621		2,755		5,257

Table 40 (con't)

Summary of Costs by Type of Development
for West Central Subarea

Activity and Related Needs	Cost per Standard Unit	State Parks: No. of Standard Units	State Parks: Cost of Facilities (000)	Public Access in Lakes: No. of Standard Units	Public Access in Lakes: Cost of Facilities (000)	Total for Subarea: Standard Unit	Total for Subarea: Cost (000)
Swimming	146,000	1.31	191			18.72	2,732
Boating & Skiing	205,000	.30	62	1.00	205	3.31	679
Camping	360,000	3.00	1,080			19.00	6,840
Picnicking	142,000	3.75	533			16.75	2,379
Sightseeing	85,000	.42	36	.08	6	2.82	240
Nature Walks	93,000	.52	48	.09	8	3.48	323
Hiking	90,000	.19	16	.03	3	1.29	116
Signs	250	9.49	3	1.20	--	65.35	17
Landscaping	1,500	9.49	15	1.20	2	65.35	100
Admin. Bldg.	6,000	9.49	56	1.20	7	65.35	391
Roads	40,000	9.49	380	1.20	48	65.35	2,614
Sewage Plant	60,000	9.49	569	1.20	72	65.35	3,921
Total Cost			2,989		351		20,352
Initial Increment			2,989		351		8,719
Future Increment			0		0		11,633

Table 41

Summary of Costs by Type of Development
for the Grand Rapids Subarea

Activity and Related Needs	Cost per Standard Unit	Sand Creek Reservoir No. of Standard Units	Sand Creek Reservoir Cost of Facilities (000)	Rogue River Reservoir No. of Standard Units	Rogue River Reservoir Cost of Facilities (000)	Valley Preserve No. of Standard Units	Valley Preserve Cost of Facilities (000)
Swimming	146,000	10.88	1,588	13.05	1,905	4.35	635
Boating & Skiing	205,000	.54	111	1.20	247	.60	123
Camping	360,000	4.00	1,440	6.00	2,160	4.80	1,728
Picnicking	142,000	5.00	710	7.50	1,065	5.00	710
Sightseeing	85,000	.89	76	.96	82	.72	61
Nature Walks	93,000	1.10	102	1.19	111	.89	83
Hiking	90,000	.41	37	.44	40	.33	30
Signs	250	22.82	6	30.34	6	16.70	4
Landscaping	1,500	22.82	34	30.34	46	16.70	25
Admin. Bldg.	6,000	22.82	137	30.34	182	16.70	100
Roads	40,000	22.82	913	30.34	1,214	16.70	668
Sewage Plant	60,000	22.82	1,369	30.34	1,820	16.70	1,002
Total			6,523		8,878		5,169
Initial Increment			2,011		1,608		878
Future Increment			4,512		7,270		4,291

Table 41 (con't)

Summary of Costs by Type of Development
for the Grand Rapids Subarea

Activity and Related Needs	Cost per Standard Unit	State Parks and Public Access: No. of Standard Units	State Parks and Public Access: Cost of Facilities (000)	Total for Subarea: Standard Unit	Total for Subarea: Cost (000)
Swimming	146,000	8.70	905*	36.98	5,033
Boating & Skiing	205,000	1.00	205	3.34	686
Camping	360,000	--	-	14.80	5,328
Picnicking	142,000	1.00	142	18.50	2,627
Sightseeing	85,000	.55	46	3.12	265
Nature Walks	93,000	.67	62	3.85	358
Hiking	90,000	.24	22	1.42	129
Signs	250	12.16	3	82.02	19
Landscaping	1,500	12.16	18	82.02	123
Admin. Bldg.	6,000	12.16	73	82.02	492
Roads	40,000	12.16	486	82.02	3,281
Sewage Plant	60,000	12.16	730	82.02	4,921
Total			2,692		23,262
Initial Increment			2,692		7,189
Future Increment			0		16,073

*Cost of developing swimming facilities on Lake Michigan shore line is $104,000 per standard unit.

Table 42

Summary of Costs by Type of Development
for the Northeast Subarea

Activity and Related Needs	Cost per Standard Unit	Lookingglass Grub Creek Reservoir: No. of Standard Units	Lookingglass Grub Creek Reservoir: Cost of Facilities (000)	Bear Creek Reservoir: No. of Standard Units	Bear Creek Reservoir: Cost of Facilities (000)	Public Access: No. of Standard Units	Public Access: Cost of Facilities (000)
Swimming	146,000	6.50	949	3.48	508	--	--
Boating & Skiing	205,000	1.20	246	.13	26	.50	102
Camping	360,000	4.80	1,728	2.40	864	--	--
Picnicking	142,000	6.00	852	2.00	284	--	--
Sightseeing	85,000	.90	77	.38	32	.04	3
Nature Walks	93,000	1.13	105	.47	44	.04	4
Hiking	90,000	.42	38	.17	15	.02	1
Signs	250	20.95	5	9.03	2	.60	--
Landscaping	1,500	20.95	31	9.03	14	.60	1
Admin. Bldg.	6,000	20.95	126	9.03	54	.60	7
Roads	40,000	20.95	838	9.03	361	.60	48
Sewage Plant	60,000	20.95	1,257	9.03	541	.60	72
Total Cost			6,252		2,745		238
Initial Increment			2,090		1,099		238
Future Increment			4,162		1,646		0

Table 42 (con't)

Summary of Costs by Type of Development
for the Northeast Subarea

Activity and Related Needs	Cost per Standard Unit	Total for Subarea: Standard Unit	Total for Subarea: Cost (000)
Swimming	146,000	9.98	1,457
Boating & Skiing	205,000	1.83	374
Camping	360,000	7.20	2,592
Picnicking	142,000	8.00	1,136
Sightseeing	85,000	1.32	112
Nature Walks	93,000	1.64	153
Hiking	90,000	.61	54
Signs	250	30.58	7
Landscaping	1,500	30.58	46
Admin. Bldg.	6,000	30.58	187
Roads	40,000	30.58	1,247
Sewage Plant	60,000	30.58	1,870
Total Cost			9,235
Initial Increment			3,427
Future Increment			5,808

Table 43

Estimates of Ultimate Visitation and Average Annual Equivalent Benefits

(Based on Eight Activities Used in This Study)

Jackson Subarea

Recreation Area	Recreation Days Ultimate	Average Annual Equivalent Benefits
Sandstone Creek	2,275,000	$1,650,000
Waterloo	51,000	37,000
Total	2,326,000	$1,687,000

Table 44

Estimates of Ultimate Visitation and Average Annual Equivalent Benefits

(Based on Eight Activities Used in This Study)

Lansing Subarea

Recreation Area	Recreation Days Ultimate	Average Annual Equivalent Benefits
Doan Creek	883,000	$ 639,000
Portland	1,211,000	877,000
No Name Creek	596,000	432,000
Lansing Valley Preserve	210,000	153,000
Sleepy Hollow State Park	346,000	251,000
Total	3,246,000	$2,352,000

Table 45

Estimates of Ultimate Visitation and
Average Annual Equivalent Benefits

(Based on Fight Activities Used in this Study)

West Central Subarea

Recreation Area	Recreation Days Ultimate	Average Annual Equivalent Benefits
Prairie Creek	912,000	$ 662,000
Duck Creek	746,000	542,000
Fish Creek	1,159,000	841,000
Ionia	153,000	111,000
Newaygo	165,000	120,000
Yankee Springs	190,000	138,000
Public Access on Lakes	92,000	67,000
Total	3,417,000	$2,481,000

Table 46

Estimates of Ultimate Visitation and
Average Annual Equivalent Benefits

(Based on Eight Activities Used in This Study)

Grand Rapids Subarea

Recreation Area	Recreation Days Ultimate	Average Annual Equivalent Benefits
Sand Creek	1,209,000	$ 877,000
Rogue River	1,669,000	1,211,000
Grand Rapids Valley Preserve	875,000	635,000
Hoffmaster State Park	566,000	410,000
Public Access on Lakes	92,000	67,000
Total	4,411,000	$3,200,000

Table 47

Estimates of Ultimate Visitation and
Average Annual Equivalent Benefits

Northeast Subarea

Recreation Area	Recreation Days Ultimate	Average Annual Equivalent Benefits
Bear Creek	456,000	$ 331,000
Lookingglass-Grub Creek	1,107,000	803,000
Public Access on Lakes	46,000	33,000
Total	1,609,000	$1,167,000

Table 48

Estimates of Average Annual
Equivalent Costs for the Proposed
Sandstone Creek Recreation Area Site 62

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($4,750,000)	$ 234,000	
Cost of future Increments discounted ($9,374,000)	184,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 418,000
Operation and Maintenance		
Initial Costs (886,000 visits)	222,000	
Cost of future increments discounted (1,389,000 visits)	144,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		366,000
Major Replacement		
Initial Costs ($4,750,000)	33,000	
Costs of future increments discounted($9,374,000)	26,000	
Total Average Annual Equivalent		
Replacement Costs		59,000
Land Costs ($1,250,000)		61,000
Development of Reservoir costs ($6,858,000)		337,000
Total Average Annual Equivalent Costs		$1,241,000

Table 49

Estimates of Average Annual
Equivalent Costs for the Proposed
Doan Creek Recreation Area Site 59

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($1,804,000)	$ 89,000	
Cost of future Increments discounted ($3,546,000)	70,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 159,000
Operation and Maintenance		
Initial Costs (291,000 visits)	73,000	
Cost of future increments discounted (592,000 visits)	61,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		134,000
Major Replacement		
Initial Costs ($1,804,000)	13,000	
Costs of future increments discounted($3,546,000)	10,000	
Total Average Annual Equivalent		
Replacement Costs		23,000
Land Costs ($500,000)		25,000
Development of Reservoir costs (3,004,000)		148,000
Total Average Annual Equivalent Costs		$ 489,000

Table 50

Estimates of Average Annual Equivalent Costs for the Proposed

Portland Recreation Area Site 51

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($2,437,000)	$ 120,000	
Cost of future Increments discounted ($5,189,000)	102,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 222,000
Operation and Maintenance		
Initial Costs (356,000 visits)	89,000	
Cost of future increments discounted (765,000 visits)	79,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		168,000
Major Replacement		
Initial Costs ($2,437,000)	17,000	
Costs of future increments discounted ($5,189,000)	14,000	
Total Average Annual Equivalent		
Replacement Costs		31,000
Land Costs ($625,000)		31,000
Development of Reservoir costs ($2,059,000)		101,000
Total Average Annual Equivalent Costs		$ 553,000

Table 51

Estimates of Average Annual
Equivalent Costs for the Proposed
No Name Creek Recreation Area Site 180

Elements of Costs		Average Annual Equivalents
Interest and Amortization		
Initial Cost ($1,558,000)	$ 77,000	
Cost of future Increments discounted ($2,104,000)	41,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 118,000
Operation and Maintenance		
Initial Costs (245,000 visits)	61,000	
Cost of future increments discounted (351,000 visits)	36,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		97,000
Major Replacement		
Initial Costs ($1,558,000)	11,000	
Costs of future increments discounted($2,104,000)	6,000	
Total Average Annual Equivalent		
Replacement Costs		17,000
Land Costs ($300,000)		15,000
Development of Reservoir costs ($600,000)		30,000
Total Average Annual Equivalent Costs		$ 277,000

Table 52

Estimates of Average Annual
Equivalent Costs for the Proposed
Lansing Valley Preserve Recreation Area

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($165,000)	$ 8,000	
Cost of future Increments discounted ($966,000)	18,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 26,000
Operation and Maintenance		
Initial Costs (37,000 visits)	9,000	
Cost of future increments discounted (210,000 visits)	22,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		31,000
Major Replacement		
Initial Costs ($165,000)	1,000	
Costs of future increments discounted ($966,000)	3,000	
Total Average Annual Equivalent		
Replacement Costs		4,000
Land Costs ($125,000)		6,000
Development of Reservoir costs		
Total Average Annual Equivalent Costs		$ 67,000

Table 53

Estimates of Average Annual
Equivalent Costs for the Proposed

Prairie Creek Recreation Area Site 42

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($2,185,000)	$ 107,000	
Cost of future increments discounted ($4,345,000)	86,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 193,000
Operation and Maintenance		
Initial Costs (302,000 visits)	76,000	
Cost of future increments discounted (610,000 visits)	63,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		139,000
Major Replacement		
Initial Costs ($2,185,000)	15,000	
Costs of future increments discounted ($4,345,000)	12,000	
Total Average Annual Equivalent		
Replacement Costs		27,000
Land Costs ($625,000)		31,000
Development of Reservoir costs ($5,400,000)		265,000
Total Average Annual Equivalent Costs		$ 655,000

Table 54

Estimates of Average Annual
Equivalent Costs for the Proposed

Duck Creek Recreation Area Site 25

Elements of Costs		Average Annual Equivalents
Interest and Amortization		
Initial Cost ($1,988,000)	$ 98,000	
Cost of future Increments discounted ($3,306,000)	65,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 163,000
Operation and Maintenance		
Initial Costs (287,000 visits)	72,000	
Cost of future increments discounted (459,000 visits)	48,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		120,000
Major Replacement		
Initial Costs ($1,988,000)	14,000	
Costs of future increments discounted ($3,306,000)	9,000	
Total Average Annual Equivalent		
Replacement Costs		23,000
Land Costs ($500,000)		25,000
Development of Reservoir costs ($2,961,000)		146,000
Total Average Annual Equivalent Costs		$ 477,000

Table 55

Estimates of Average Annual
Equivalent Costs for the Proposed

Fish Creek Recreation Area Site 47 A

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($2,281,000)	$ 112,000	
Cost of future Increments discounted ($6,308,000)	124,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 236,000
Operation and Maintenance		
Initial Costs (40,000 visits)	85,000	
Cost of future increments discounted (819,000 visits)	85,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		170,000
Major Replacement		
Initial Costs ($2,281,000)	16,000	
Costs of future increments discounted ($6,308,000)	17,000	
Total Average Annual Equivalent		
Replacement Costs		33,000
Land Costs ($750,000)		37,000
Development of Reservoir costs ($5,130,000)		252,000
Total Average Annual Equivalent Costs		$ 728,000

Table 56

Estimates of Average Annual
Equivalent Costs for the Proposed

Grand Rapids Valley Preserve Recreation Area

Elements of Costs		Average Annual Equivalents
Interest and Amortization		
Initial Cost ($1,034,000)	$ 51,000	
Cost of future Increments discounted ($6,203,000)	122,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 173,000
Operation and Maintenance		
Initial Costs (177,000 visits)	44,000	
Cost of future increments discounted (698,000 visits)	73,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		117,000
Major Replacement		
Initial Costs ($1,034,000)	7,000	
Costs of future increments discounted ($6,203,000)	17,000	
Total Average Annual Equivalent		
Replacement Costs		24,000
Land Costs ($600,000)		30,000
Development of Reservoir costs		
Total Average Annual Equivalent Costs		$ 344,000

Table 57

Estimates of Average Annual
Equivalent Costs for the Proposed

Sand Creek Recreation Area Site 74

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($2,403,000)	$ 118,000	
Cost of future Increments discounted ($5,414,000)	106,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 224,000
Operation and Maintenance		
Initial Costs (339,000 visits)	85,000	
Cost of future increments discounted (870,000 visits)	90,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		175,000
Major Replacement		
Initial Costs ($2,403,000)	17,000	
Costs of future increments discounted ($5,414,000)	15,000	
Total Average Annual Equivalent		
Replacement Costs		32,000
Land Costs ($750,000)		37,000
Development of Reservoir costs ($4,107,000)		202,000
Total Average Annual Equivalent Costs		$ 670,000

Table 58

Estimates of Average Annual
Equivalent Costs for the Proposed

Rogue River Recreation Area Site 19 A

Elements of Costs	Average Annual Equivalents	
Interest and Amortization		
Initial Cost ($1,930,000)	$ 95,000	
Cost of future Increments discounted ($8,694,000)	171,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 266,000
Operation and Maintenance		
Initial Costs (286,000 visits)	72,000	
Cost of future increments discounted (1,383,000 visits)	143,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		215,000
Major Replacement		
Initial Costs ($1,930,000)	13,000	
Costs of future increments discounted ($8,694,000)	24,000	
Total Average Annual Equivalent		
Replacement Costs		37,000
Land Costs ($1,000,000)		49,000
Development of Reservoir costs ($5,000,000)		246,000
Total Average Annual Equivalent Costs		$ 813,000

Table 59

Estimates of Average Annual
Equivalent Costs for the Proposed

Bear Creek Recreation Area Site 109

Elements of Costs		Average Annual Equivalents
Interest and Amortization		
Initial Cost ($1,319,000)	$ 65,000	
Cost of future Increments discounted ($1,975,000)	39,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 104,000
Operation and Maintenance		
Initial Costs (191,000 visits)	48,000	
Cost of future increments discounted (265,000 visits)	27,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		75,000
Major Replacement		
Initial Costs ($1,319,000)	9,000	
Costs of future increments discounted ($1,975,000)	5,000	
Total Average Annual Equivalent		
Replacement Costs		14,000
Land Costs ($250,000)		12,000
Development of Reservoir costs ($450,000)		22,000
Total Average Annual Equivalent Costs		$ 227,000

Table 60

Estimates of Average Annual
Equivalent Costs for the Proposed

Lookingglass - Grub Creek Recreation Area Sites 148 & 149

Elements of Costs		Average Annual Equivalents
Interest and Amortization		
Initial Cost ($2,508,000)	$ 123,000	
Cost of future Increments discounted ($4,994,000)	98,000	
Total Average Annual Equivalent		
Interest and Amortization Costs		$ 221,000
Operation and Maintenance		
Initial Costs (369,000 visits)	92,000	
Cost of future increments discounted (738,000 visits)	77,000	
Total Average Annual Equivalent		
Operation and Maintenance costs		169,000
Major Replacement		
Initial Costs ($2,508,000)	17,000	
Costs of future increments discounted ($4,994,000)	14,000	
Total Average Annual Equivalent		
Replacement Costs		31,000
Land Costs ($500,000)		24,000
Development of Reservoir costs ($910,000)		45,000
Total Average Annual Equivalent Costs		$ 490,000

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FISH AND WILDLIFE

APPENDIX K
TO THE
COMPREHENSIVE PLANNING STUDY
OF THE
GRAND RIVER BASIN, MICHIGAN

Prepared by the
U. S. Department of the Interior
Bureau of Sport Fisheries and Wildlife

ACKNOWLEDGEMENTS

The Bureau of Sport Fisheries and Wildlife received cooperation from many agencies, groups, and individuals. We are especially indebted to the Michigan Department of Conservation for their valuable assistance in furnishing analytical data, providing planning guidance, and supplying fish and wildlife photographs.

Michigan State University and the University of Michigan furnished source materials which were extremely useful. The Michigan Water Resources Commission, Tri-County Regional Planning Commission, and Battelle Memorial Institute all provided additional information necessary to our study.

Corollary information was furnished by the Economic Research Service, Soil Conservation Service, and Forest Service of the U.S. Department of Agriculture. The Bureau of Commercial Fisheries, Bureau of Outdoor Recreation, Geological Survey, and Federal Water Pollution Control Administration of the U.S. Department of Interior also contributed useful data, as did the Detroit District, Corps of Engineers, Department of the Army.

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(Courtesy of the Michigan Department of Conservation)

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SYNOPSIS

The U. S. Bureau of Sport Fisheries and Wildlife is pleased to present a report on the Fish and Wildlife Resources of the Grand River Basin, Michigan, to be included as Appendix "K" in the Grand River Basin Comprehensive Water Resources Study. This report has been prepared under the authority, and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401 as amended; 16 U.S.C. 661 et seq.).

The report is designed to analyze the fish and wildlife resource problems in the Grand River Basin, and to furnish a plan for satisfying these resource problems which can be incorporated into a multiple-purpose Basin plan for meeting all water and related land resource demands expected in the near future.

This report was undertaken with the cooperation of the Michigan Department of Conservation. The study's findings and projections have been reviewed and generally concurred with by pertinent Divisions of the Department of Conservation, as well as other Federal agencies involved in the study. Numerous State and Federal agencies furnished basic data. The cooperation of your Basin Planning Branch was significant.

In 1960, approximately 203,000 residents of the Basin were anglers. However, because of the Basin's inability to sustain fishing demands and the angler's traditional use of out-of-Basin facilities, only about 147,000 anglers, fishing 1.52 million days, used Basin resources. Approximately 174,000 Basin residents hunted in 1960, but similarly to fishing, only 147,000 hunters used Basin resources a total of 1.46 million days.

Gross demand for sport fishing is projected to increase 32% by 1980, 75% by 2000, and 120% by 2020 over the 1960 actual Basin use. Fishing opportunity to sustain an additional 483,000 angler-days use will be needed by 1980, 1,130,000 by 2000, and 1,824,000 by 2020, over that available in 1960.

The growth in hunter demand, while slower than fisherman demand, is projected to increase 23% by 2000 and ultimately increase 56% by 2020, when compared with the 1960 actual Basin use. Although demands for additional hunting opportunities are not projected for 1980, 111,000 man-days of additional opportunity will be needed by 1985. By 2000, net hunter demands within the Basin are expected to require facilities to sustain 444,000 additional user days. Unfulfilled demand will then increase to 1,008,000 hunter-days by 2020.

Hunting and fishing opportunity through the Basin can be provided by increasing the production and utilization of existing resources and

by developing new sources of opportunity. Increased utilization of existing resources may be accomplished by improving water quality (by curbing all forms of pollution); by preventing degradation of resources (unique or otherwise) through unwarranted dredging, filling, and other habitat modification practices; by providing or acquiring public access to some 6,300 acres of quality fishing waters in the Basin; by continued progressive management programs based on sound biological principles supplied by research; by providing equitable use of available public accessed lands and waters through zoning; by relaxation of overly restrictive regulations such as the ban on hunting mourning doves; and by proper water resource planning to avoid possible loss of fish and wildlife resources through ill-advised construction programs.

New Basin fishing and hunting opportunities may be developed or created by the introduction of promising species, such as the Michigan Department of Conservation Fish Division's Pacific salmon program; by opening additional hunting and fishing areas to public use through purchase, lease, or easement; and by constructing various types and sizes of impoundments and developing the associated project lands to meet fishing and hunting demand.

Fish and wildlife development plans of all conservation entities have been detailed for each of the five Basin subareas. Each subarea plan lists acreage and expected usage of projected non-federal fish and wildlife developments expected to be completed prior to 1980. Satisfying the remaining unfulfilled demand is this study's responsibility. To this end, an array of reservoir sites and associated land areas, capable of best meeting the remaining net hunting and fishing demand, have been identified in this report. Subarea planning maps are provided to locate selected sites.

The annual amortized costs for this fish and wildlife program are estimated to total a minimum of $635,000, with portions cost-shared by non-federal interests. Fish and wildlife benefits from the plan could total at least $875,000 annually by 1980. These programs will be partially financed by existing revenue sources, which include State hunting and fishing license funds, Federal Aid programs and miscellaneous State revenue sources. The 1965 Anadromous Fish Act, the Land and Water Conservation Act, and the Pittman-Robertson and Dingell-Johnson Restoration Funds could provide substantial sums for funding near-future programs.

Several statutes have been established to allow cost-sharing and long-term repayment plans for the State's share at Federal multipurpose projects. There are also a number of methods of providing additional fishing and hunting opportunities with little or no cost to any resource oriented agency. All of the above methods are discussed in the report.

SECTION I

INTRODUCTION

1. AUTHORITY

This is a report on the fish and wildlife resources and the needs for hunting and fishing opportunity in the Grand River Basin, Michigan. The report has been prepared under the authority, and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.)

The Grand River Basin Study was authorized by a resolution of the Committee on Public Works of the United States House of Representatives, adopted August 16, 1950.

2. SCOPE

The survey of the Grand River Basin was re-defined as a Type II Study (Comprehensive Detailed Plans) in November 1962. The basic objective in the formulation of a comprehensive plan for the Grand River Basin is to provide for a general appraisal of overall water and related land resource development involving longrun projections of economic development, translation of such projections into demands for water and related land resource uses, hydrologic projections of water availability, both as to quantity and quality, and projections of related land resource availability similar to Type I Surveys. In addition, this Type II study defines and evaluates the Federal or Federally-assisted projects for which Federal authorization will be required to permit necessary construction to be initiated in the next 10 to 15 years in sufficient detail to comprise a basis for authorization.

3. PREVIOUS STUDIES

The fish and wildlife resources of the Grand River Basin have been studied previously in connection with several water and associated land development proposals. Reports prepared by the Fish and Wildlife Service in 1949, 1950, 1954, and 1965 reviewed local flood protection projects within the Basin. In each case, only minor detrimental effects on fish and wildlife were expected. A 1959 report by the Fish and Wildlife Service, relative to major drainage and flood control for the Portage River, objected to Federal participation . . . "in a project which provides primarily for more intensive agriculture at the expense of important wildlife habitat . . . . .". This project was found infeasible from an economic standpoint, partially because of its effects on wildlife habitat in the Waterloo Recreation Area.

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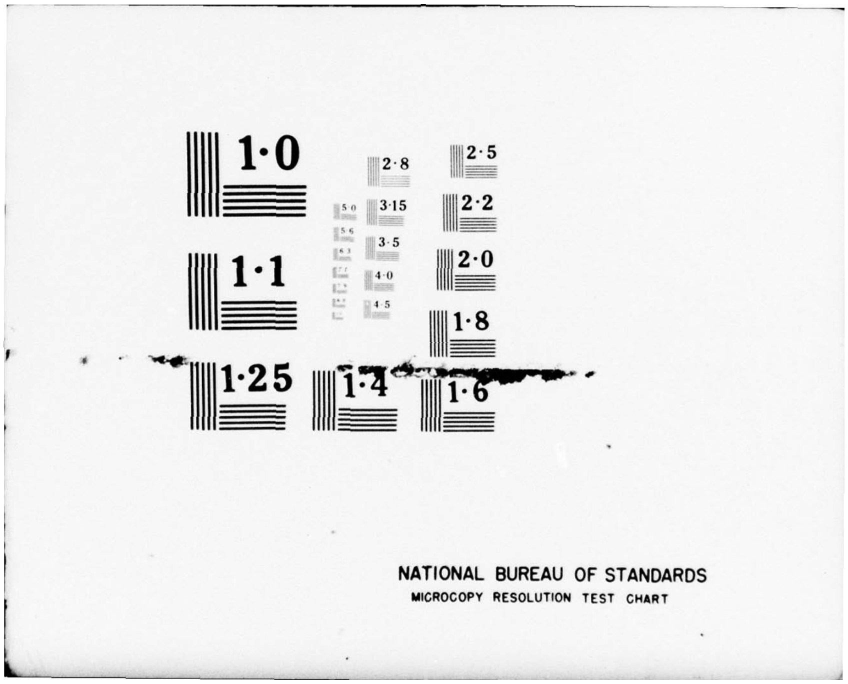
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NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

A 1955 Service report to the District Engineer commented on proposed drainage projects involving agricultural lands along four major tributaries of the Grand River. No serious losses were indicated. Fish and wildlife enhancement possibilities were discussed. A preliminary 1960 report indicated that no significant effects would result to fish and wildlife from a proposed local flood protection project at Grandville, Michigan.

The fish and wildlife aspects of several small watershed projects (PL-566 are being studied. Fish and wildlife reports on the following projects have been submitted to the Soil Conservation Service State Conservationist: Misteguay, 1957; Muskrat Creek, 1960; Black Creek, 1963; Catlin-Waters, 1964; and, Upper Maple River, 1966.

4. RESPONSIBILITY

The first appropriation of Federal funds for the Grand River Comprehensive Study was made in Fiscal Year 1963; the Bureau of Sport Fisheries and Wildlife initiated its studies at that time. Studies were handled by the Minneapolis Area Office, Division of River Basin Studies, Minneapolis, Minnesota, until August 1966; at which time, responsibilities for the study were transferred to the Ohio Area Office, Division of River Basin Studies, Lebanon, Ohio. Each Area Office collected and analyzed information on the status of sport fishery and wildlife resources. The Ohio Area Office was responsible for projective methodology, development of a single-purpose fish and wildlife plan, and preparation of Fish and Wildlife Appendix K. The River Basin Section, Bureau of Commercial Fisheries, Great Lakes and Central Regional Office, Ann Arbor, Michigan, was responsible for preparing the portion of the report concerning commercial fisheries of the Basin.

5. GLOSSARY OF REPORT TERMS

a. Angler-day. Any portion of a given 24 hour day devoted to fishing.

b. Catch. The annual harvest of fish or shellfish from any particular area.

c. Correlation. A measure of the intensity of the relationship between two or more variables.

d. Farm-game habitat. Land usually associated with populations of cottontail rabbits, ring-necked pheasant or other comparable species; and listed in the Soil Conservation Service's "Conservation Needs Inventory" as Cropland, Pasture, Range, and appropriate acreages of Other Land categories.

e. <u>Forest-game habitat</u>. Land usually associated with populations of deer, squirrels, raccoons, or other comparable species; and listed in the Soil Conservation Service's "Conservation Needs Inventory" as <u>Forest and Woodland</u> or appropriate <u>Other Land</u> categories.

f. <u>Gross demand</u>. Total demand generated by hunters and sport fishermen during a given calendar year: usually expressed as man-days-of-use.

g. <u>Harvest</u>. The annual take of game birds or animals from any particular area.

h. <u>Hunter-day</u>. An individual hunting effort consisting of any part of one 24-hour day.

i. <u>Latent demand</u>. That desire to pursue an activity which is inherent in the total population but is not fulfilled because of lack of facilities, leisure time, or other pertinent factors.

j. <u>Linear regression</u>. The degree to which a dependent variable will increase or decrease with a unit change of an independent variable, resulting in an association which can be adequately represented by a straight line when plotted.

k. <u>Mean</u>. An average; the sum of a given set of values divided by the number of values.

l. <u>Median</u>. A value in a given set of values below and above which there are the same number of values.

m. <u>Multiple regression</u>. The degree in which one dependent variable increases or decreases with the change of two or more independent variables.

n. <u>Net demand</u>. Net demands are projected when estimated gross demand exceeds projected opportunity. Net demand is expressed in hunter- and angler-days.

o. <u>Non-resident</u>. An individual who resides in a state other than Michigan but who hunts and/or fishes in Michigan, paying a premium license fee to do so.

p. <u>Opportunity</u>. Lands or waters where an individual may gain access, and upon which he may hunt or fish. An index of opportunity is available by dividing acres of hunting or fishing habitat, by the population residing in that particular area.

q. <u>Participant</u>. An individual who hunts or fishes.

r. Participation. The number of times an individual hunts or fishes in a particular year.

s. Ponded water. Waters which are not in a free-flowing state.

t. Pressure. The number of user-days a particular hunting or fishing area receives over a particular length of time.

u. Projection. A forecast based on certain assumptions.

v. Quality stream. Streams providing a significant trout, bass, or walleye fishery.

w. Relict. Something left unchanged among changed surroundings; this is a special case of survival where the resource, though essentially untouched is, relatively, merely a remnant of the former range or expanse of that resource.

x. Resident. An individual hunting and/or fishing in the same state where he resides.

y. Significant. This term, in a statistical sense, is used for stating results of an appropriate statistical test. When the probability of the occurrence of a particular event is 19 in 20 or more (P = 0.95), the probability is termed significant. When the probability is 99 in 100 or more (P = 0.99), it is termed highly significant.

z. Streams. Water in a free-flowing state; it may locally be called a river, stream, creek, brook, watercourse, or some other descriptive term.

aa. Urban area. Incorporated places of 2,500 inhabitants or more.

bb. User-day. An individual participating in a recreation activity during any part of a 24-hour day.

cc. Utilization. (See Pressure).

SECTION II

DESCRIPTION OF THE AREA

6. GEOGRAPHY

The Grand River Basin, located in the southern part of the Lower Peninsula of Michigan (Figure 1), is nearly oval in shape. It is 135 miles long and 70 miles wide. A drainage area of 5,572 square miles ranks it as the second largest basin in the State. The study area includes the counties of Barry, Clinton, Eaton, Gratiot, Ingham, Ionia, Jackson, Kent, Montcalm, Ottawa, and Shiawassee. The counties of Allegan, Calhoun, Hillsdale, Livingston, Mecosta, Muskegon, Newaygo, and Washtenaw all have small portions lying within the hydrologic limits of the Basin, but were not included in this study.

Delineation of the planning subareas is the same as set forth in the Economic Base Study (1/I-46 through I-53).* They are:

<u>Grand Rapids Subarea</u>

Kent County
Ottawa County

<u>Lansing Subarea</u>

Clinton County
Eaton County
Ingham County

<u>West Central Belt Subarea</u>

Barry County
Ionia County
Montcalm County

<u>Northeast Fringe Subarea</u>

Gratiot County
Shiawassee County

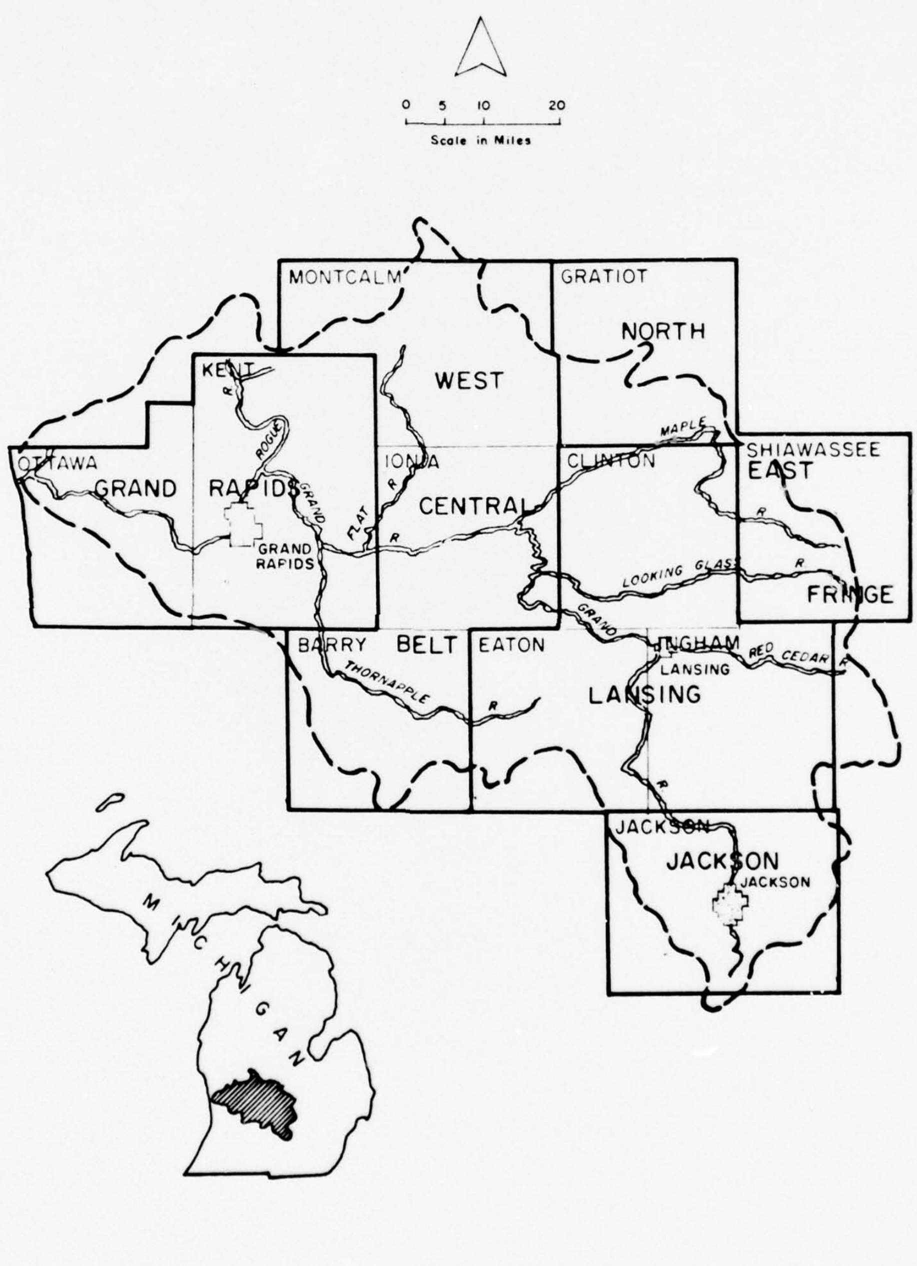
<u>Jackson Subarea</u>

Jackson County

The Grand River rises in the northern part of Hillsdale County, flows northward to Lansing, then northwesterly to the mouth of the Maple River near Muir, and finally through Grand Rapids, emptying into Lake Michigan at Grand Haven. The Basin has six major tributaries which control 61 percent of its drainage area. The Rogue, Flat, and Maple Rivers enter from the north; the Thornapple enters from the south; and the Looking Glass and Red Cedar Rivers flow from the east (Figure 1).

*The number prior to the diagonal line refers to the reference cited and that reference may be located in the bibliography by that number. The number after the diagonal locates the pages in the cited publication where the subject is discussed in further detail.

FIGURE 1. DELIMITATION OF SUBAREAS IN THE GRAND RIVER BASIN SERVICE AREA



The gradient of the main stem from its headwaters to the vicinity of Grand Ledge is about 1.9 feet per mile, then about 3.2 feet per mile to the City of Ionia, and then 0.5 feet per mile to Lake Michigan. The gradients of the tributaries, except for the Maple River, are about 3 feet per mile. The Maple River Basin has a very flat gradient, which was created, according to geological history, when the Saginaw River Basin immediately to the east drained through this area into the Grand River Basin. The cross-sections of the main stem and its tributaries are generally wide, with several feet of water flowing in the channels during the normal flow period.

7. GEOLOGY

The Basin is the product of complex glacial actions which left significant land marks on the area. An extensive till plain is the most outstanding post-glacial feature. Ice action left three distinct lobes: Saginaw lobe in the northeast, Erie lobe in the east, and Michigan lobe in the northwestern portion of the Basin. Advances and retreats and melting of these ice lobes formed the Grand River Basin, an area generally consisting of limited relief, fertile soils, and few natural lakes. Exceptions occur in two well-defined areas where the lobes met, creating strong end morainic topography. The Saginaw-Erie junction affects eastern Jackson County. The Saginaw-Michigan junction includes all of Barry, eastern Kent, and part of Montcalm Counties. In these areas, considerable relief occurs, soils are less fertile, and there are many natural lakes (Figure 2).

Sandy loam soils predominate over the entire Basin. Gravel deposits are common, with little clay or ledge rock in evidence. Black muck and acid peat soils characterize many of the lower, more poorly drained areas.

8. CLIMATE AND HYDROLOGY

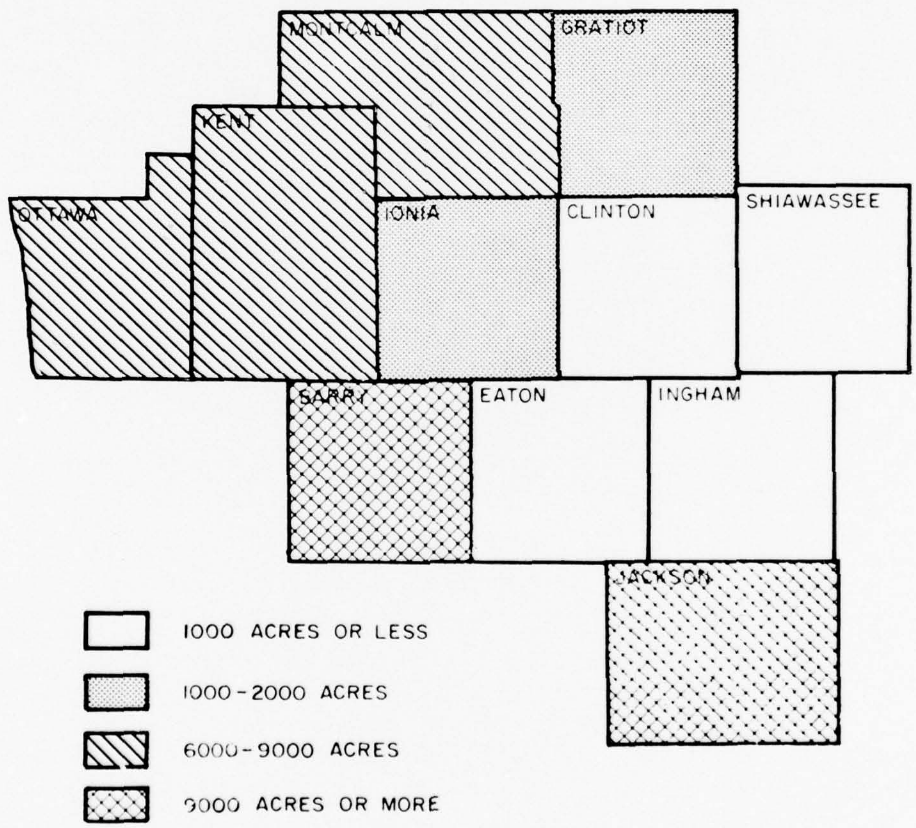
The Great Lakes have a stabilizing effect on Basin temperatures; because of the prevailing westerly winds, winters are generally milder and summers cooler than at similar latitudes.

The average annual precipitation recorded in the Basin is 31 inches. Runoff is about 33 percent of the annual rainfall. Rainfall distribution is fairly uniform throughout the year. Snowfall varies from a negligible amount to several feet during the winter seasons. The mean temperatures throughout the Basin vary from about 74 degrees during the summer months to about 22 degrees during the winter months, with recorded extremes of 109 and -33 degrees F.

9. LIMNOLOGY

Approximately 2 percent of the Basin is covered by some form of aquatic habitat. Most of the lakes in the Basin are less than 200 acres in

FIGURE 2. PRESENT DISTRIBUTION OF PONDED WATER, BY COUNTY, IN THE GRAND RIVER BASIN



size, possessing distinct drainage and hard waters. Seepage lakes, showing various stages of bog succession and confined to limited areas within the Basin, are also present. These lakes are small and shallow, with colored, acid waters, and are surrounded by sphagnum and other characteristic bog vegetation. Marl lakes form a third category of lentic waters (2/96). They range in character from those with slight encrustations on exposed surfaces and fine particles mixed in the organic sediment to others with heavy encrustations in addition to depositions in the form of flocculates and concretions.

10. LAND USE TRENDS

Prior to 1830, the Grand River Basin was a heavily forested, unbroken wilderness. A native pine forest flourished on the dunelands of extreme western Ottawa County. The remainder of western Ottawa County and northern portions of Kent, Montcalm, and Gratiot Counties supported mixed stands of hardwoods and conifers. Elm, oak, ash, maple, and hickory predominated over the rest of the Basin.

Although a similar distribution of tree species exists today, less than 20 percent of the Basin is forested. Of this forested area, over 90 percent is located in farm woodlots. The Basin comprises approximately 3,500,000 acres of level to rolling farmland. Although the Basin drains 10% of the land of the State, it contains over 18% of the cropland.

11. POPULATION

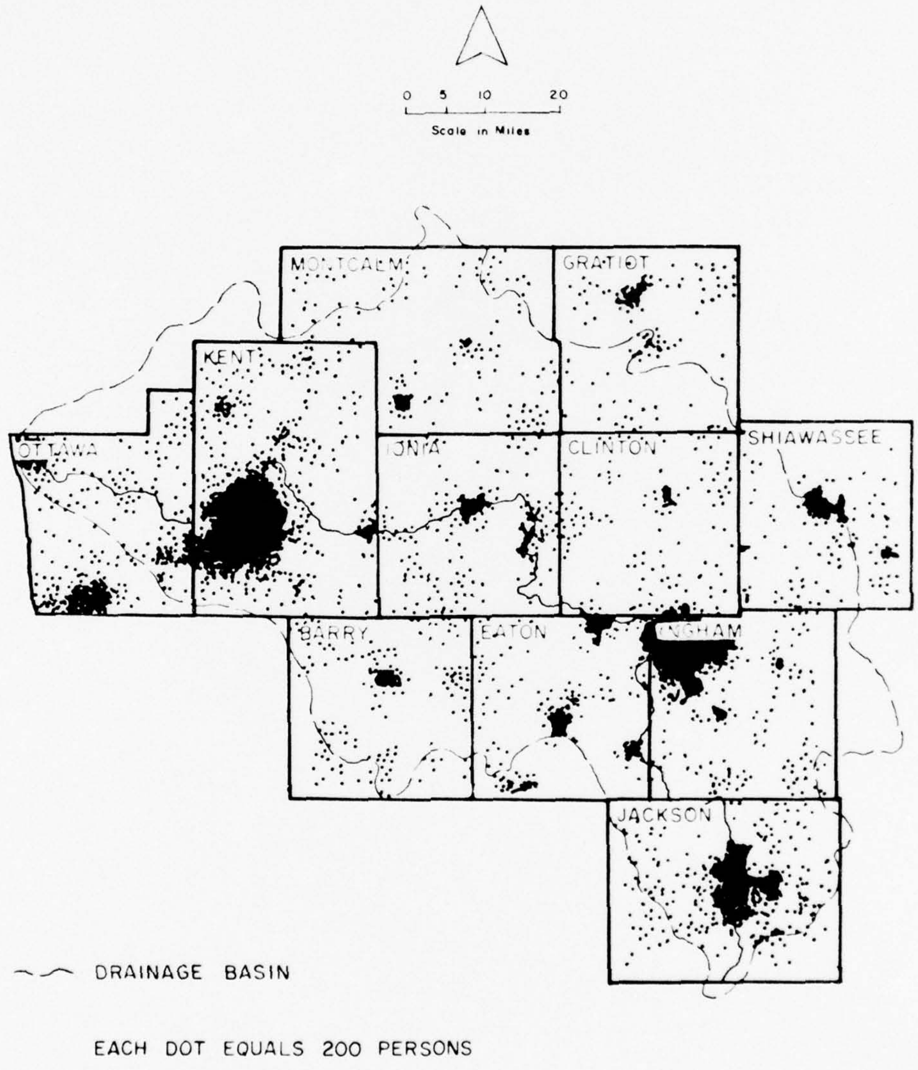
The 1960 census credited the 11-county Grand River Basin study area with slightly under 1.1 million inhabitants. About half of these people resided in the Grand Rapids, Lansing, and Jackson metropolitan areas; over 35 percent of the total population were classified as rural; and the remainder lived in small towns (Figure 3). The population density in 1960 averaged 162 people per square mile over the entire Basin. Kent County had 421 people per square mile, Ingham County followed with 378, Jackson County had 187, and Ottawa was the remaining County with over 100 people per square mile, having 175. All other counties range from 50 (Montcalm) to 99 (Shiawassee) people per square mile.

Both past and projected population growth patterns are typical of other midwestern states. Rapid expansion is characteristic of urban centers, smaller rural communities are sustaining limited growth, and the rural farm population is declining.

From 1950 to 1960, the Basin's population increased 23.2%, exceeding the percentage increases of the State - 22.8% and the Nation - 18.5%.

FIGURE 3. POPULATION DISTRIBUTION IN THE AREA, 1960

Source: Derived from U.S. Census of Population, 1960



12. INDUSTRY

Grand Rapids, which gained early fame as a furniture manufacturing center, now has a more diversified industrial base, and is the wholesale and retail trade center of western Michigan. Fabricated metal products, furniture, and instruments are the city's most important products, but it manufactures an array of other goods, both durable and nondurable, including bakery products, textiles and leather, electrical machinery, and household refrigerators and freezers.

The Basin's most important industry is the manufacture of automobiles and automobile parts, a characteristic which it shares with the rest of the State. The Basin's automobile industry is centered in Lansing, accounting for two-thirds of the city's manufacturing employment. Although primarily dependent upon the automobile industry, it is also the capital of Michigan; and its largest suburb, East Lansing, is the site of Michigan State University.

Jackson is dominated by the transportation industry. It manufactures parts and equipment for automobiles and airplanes, and tires and tubes. Long a supplying city for the automobile industry, it has developed along lines that have encouraged diversification into the fields of electrical machinery and electronic components.

Mineral resources include petroleum in Jackson County and sand and gravel throughout the Basin. Natural gas, salt, brine, peat, marl, and limestone are also important.

13. *TRANSPORTATION*

The lower Peninsula of Michigan has one of the better highway systems in the United States. Freeways link urban centers and provide excellent access to the lake country of the north. The Basin is served by five railroads and three airlines. The Grand Haven harbor averages about 3 million tons of waterborne commerce per year. The lower $17\frac{1}{2}$ miles of the Grand River serves as a sand and gravel barge route.

SECTION III

PRESENT STATUS OF FISH AND WILDLIFE RESOURCES

14. BASIN FISH AND WILDLIFE POPULATIONS

Fish and wildlife populations are limited by a multiplicity of factors, not the least of which are the availability of suitable natural habitat, and ever expanding human populations with their inevitable demands on lands and waters. The Grand River Basin is fortunate in having a diversity of fish and wildlife habitat, but this enhancement is dampened by the Basin's rapid human population growth. Rapidly increasing populations not only limit this Basin's fish and wildlife habitat base through local urban sprawl, intensive agricultural practices, and stream pollution; but also place extreme demands on the Basin's existing hunting and fishing facilities and resources.

a. Stream fisheries. Coldwater streams, totaling 237 miles, were located in three planning subareas in 1964. There were approximately 112 miles of stream capable of producing or sustaining trout in the Grand Rapids Subarea, 110 miles in the West Central Subarea; and, 15 miles in the Jackson Subarea. Marginal trout streams, where trout were stocked occasionally, were also present in nearly every county.

The balance of the headwater streams, which run generally clear and unpolluted, sustain fishable populations of smallmouth bass, rock bass, and walleye. Approximately 430 stream miles of smallmouth bass - walleye habitat existed in the Basin in 1964. The Grand Rapids Subarea had 80 miles, West Central Subarea 117 miles, Lansing Subarea 143 miles, Northeast Fringe Subarea 45 miles, and Jackson Subarea 45 miles of this type of habitat.

The lower reaches of the smaller tributary streams, plus major streams in the lowlands, are productive of carp, catfish, bullhead, largemouth bass, pike, perch, crappies, sunfishes, bluegill, suckers, and other less important species. Smelt runs are present in tributaries to several lakes. The major streams and main stem of the Grand River often contain ecological factors which inhibit the game fish population and promote a higher ratio of non-game species. Species of game fish having restrictive habitat requirements occur rarely or as transients in many portions of these larger rivers.

Summaries of miles of trout, bass, and walleye stream habitat, and miles of other fishable stream miles occurring in the Basin in 1964 appear in Table 1, Columns 1 and 2.

Pollution from industrial, municipal, and agricultural sources seriously limits production and alters habitat quality in portions of Basin

streams. Determinations of pollution significant to sport fisheries vary; however, it has been estimated that nearly 140 stream miles are significantly affected by influx of organic runoff and the addition of industrial and/or municipal wastes (Figure 4). Approximately 60 miles or over 40 percent of waters subjected to chronic pollutional influxes do not support a quality sport fishery. The remaining 80 miles are degraded through sporadic fish kills resulting from pollution. Lack of seasonally sustained flows in many Basin streams compounds pollution problems.

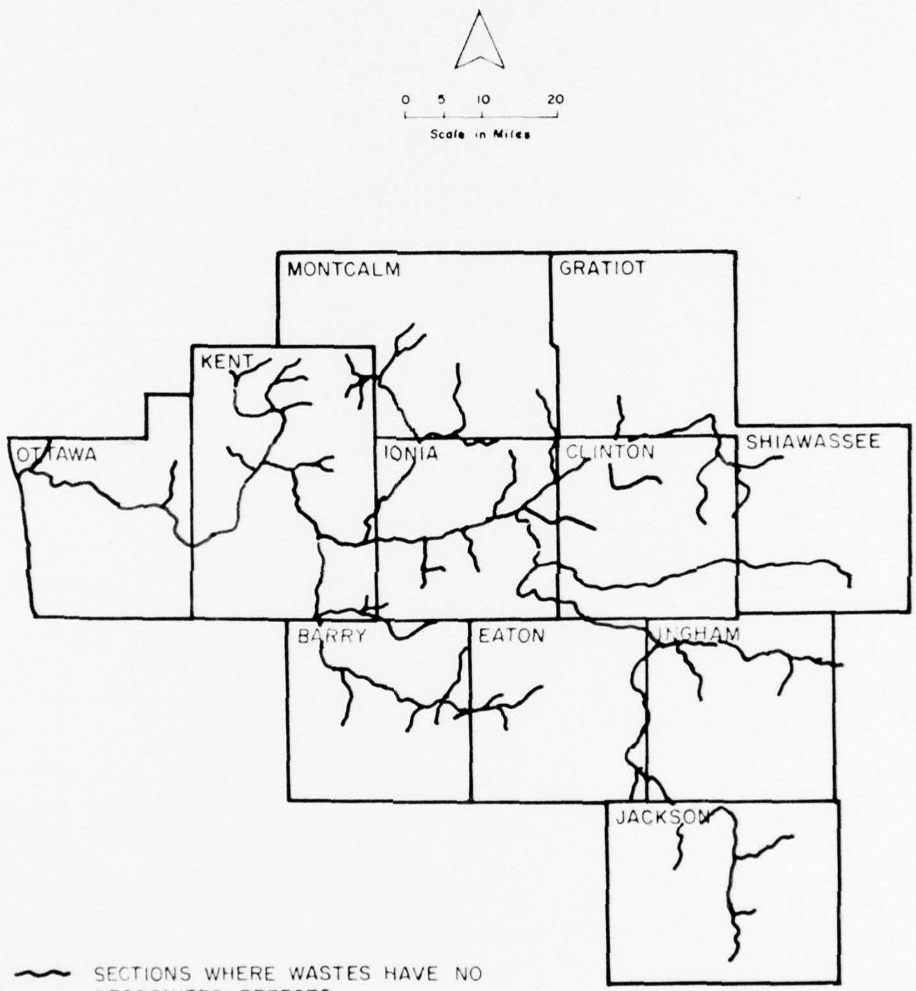
b. Reservoir, lake, and pond fisheries. The Basin has approximately 50,000 acres of ponded water, of which about 70% of the total acreage are natural lakes; 16%, natural lakes with water level controls; 13%, impoundments; and 1% excavated lakes or farm ponds (Table 1, Col. 3). Lake Michigan, which borders Ottawa County for about 25 miles, sustains an important perch sport-fishery. The inland lakes, impoundments, and ponds are nearly exclusively warmwater fisheries, consisting primarily of panfish, bass, walleye, perch, and related species.

The Michigan Department of Conservation general creel census provides rough estimates of the makeup of the sport fish population (Table 2). During routine contacts by Conservation Officers, catch data is gathered. Information on the Grand River Basin from 1958 through 1962 shows a preponderant catch of panfish. Estimates of catch of individual species may have been over- or under-expressed depending upon the officer's tendency to concentrate on a particular area or habitat type. This census was designed to measure catch, not fishable populations; therefore, problems encountered in using it as a population measurement must be expected.

The Michigan Department of Conservation introduced the coho or silver salmon into two Lake Michigan tributaries during the spring of 1966. These 4 to 6-inch fingerling salmon showed tremendous growth. By October of 1966, the fish averaged about three pounds in weight, with the largest over seven pounds (3/4). The potential for this fishery is great. Success to date with this program has encouraged the Department of Conservation to launch an introduction of chinook (king) salmon. There have been limited introductions of kokanee (landlocked sockeye) salmon in northern Michigan lakes, and the introduction of striped bass as an anadromous fish is under consideration.

Any, or all, of these species could have a great effect upon the future Lake Michigan fishery. Not only would they be desirable sport fishery species, but they could also provide a degree of predation necessary to control the burgeoning alewife population. One of the alewife's foods is fish eggs, and if this predation goes unchecked, it could result in major problems of egg survival for other Great Lakes fish species (4/5).

FIGURE 4. FISHING QUALITY OF MAJOR STREAMS CAPABLE OF SUPPORTING A SPORT FISHERY IN THE GRAND RIVER BASIN



SECTIONS WHERE WASTES HAVE NO RECOGNIZED EFFECTS.

SECTIONS SOMETIMES DETRIMENTALLY AFFECTED BY THE INFLUX OF ORGANIC RUNOFF AND THE ADDITION OF INDUSTRIAL AND/OR MUNICIPAL WASTE.

SECTIONS WHERE THE FISHERY HAS BEEN DOWNGRADED BY THE ADVERSE EFFECTS OF INDUSTRIAL AND/OR MUNICIPAL WASTE.

The Grand River and its major tributaries possess qualities that could be suitable for salmon or striped bass reproduction. If spawning runs were established in the Basin, anglers would enjoy unique fishery experiences.

The quality of the lake and artificial pond fisheries in 1965 was judged by the Michigan Department of Conservation to be good at 41% of the total acreage, medium at 40% of the acreage and poor on the remaining 19%. Quality is difficult to determine because it is a subjective measure meaning different things to different individuals.

c. Big game. The white-tailed deer is the only remaining big game animal in the Grand River Basin. Black bear, elk, and bison were once residents of this area, but were extirpated with increasing settlement.

Deer are presently increasing in southern Michigan counties (Figure 5-A). Jenkins (5) states:

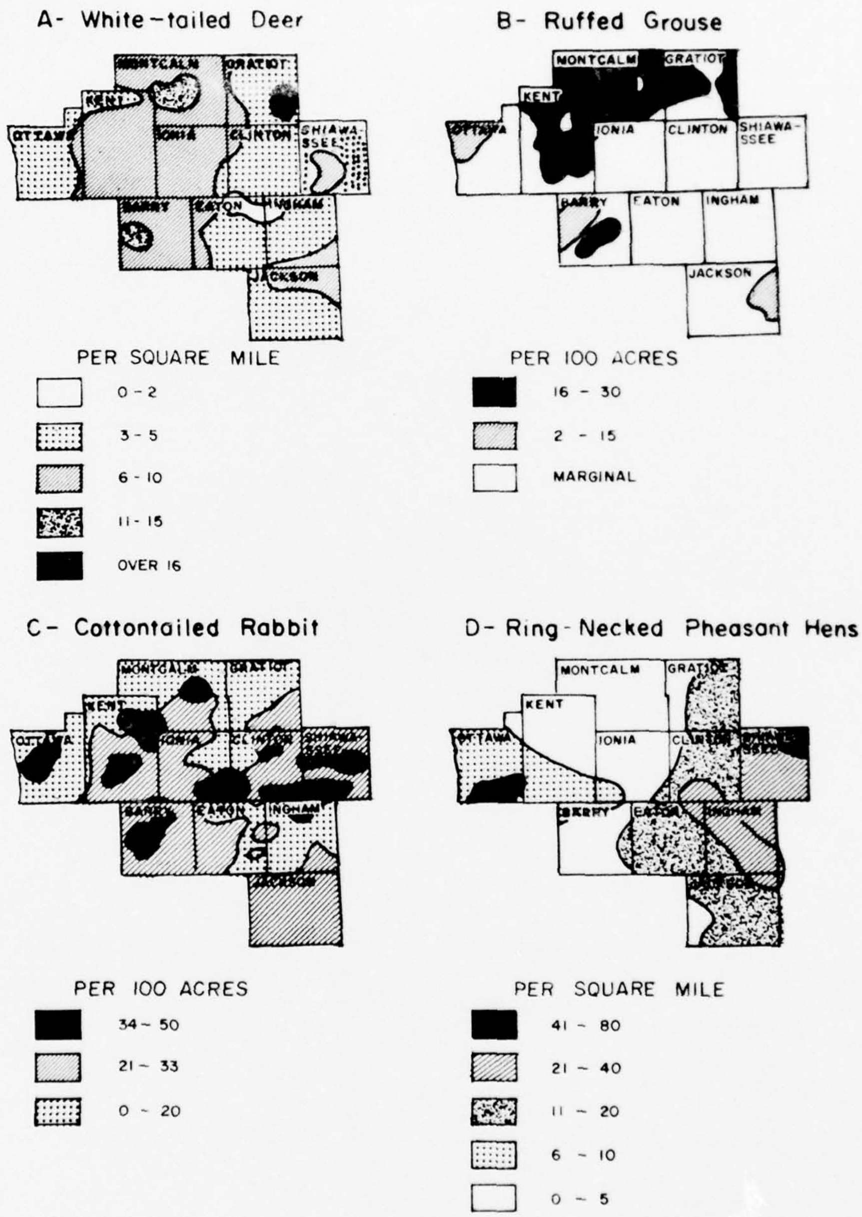
> "Before southern Michigan was settled, deer were found here in good numbers. Early records show that they were probably more abundant than in the North. After 1850, with increasing settlement of the area, the herd began to decline. No single factor can account for this 'disappearance' of deer. The very rapid change in the habitat brought about by land clearing, widespread market hunting, and year-round shooting for food and clothing all contributed. By 1900, deer were extremely rare south of Highway M-46 [a line from Muskegon through Saginaw, Michigan]. The herd 'returned' in the 1920's. By 1943 deer were present in every [southern] county. In 1948, a general firearms season was opened for the first time in recent years. The latest information available indicates a net annual increase of about 14 percent. At this time we can foresee a herd of from 80,000 to 90,000 deer [in southern Michigan] within 5 years [1968]."

In an attempt to stabilize the rapidly increasing herd in the farming country, Michigan established a new feature to the 1964 deer season. Antlerless deer hunting was allowed in certain Michigan areas; four such areas occurred within the Basin. These special Basin areas were increased to 11 for the 1965 season. The average annual estimated Basin deer harvest from 1959 through 1963 had been nearly 2400 animals (Table 3, Column 1), as derived from Michigan Department of Conservation harvest figures.

d. Small game.

(1) Forest species. Fox squirrels and gray squirrels are present over the entire Basin. Gray squirrels are common within the

FIGURE 5. DISTRIBUTION AND DENSITIES OF FOUR MAJOR GAME SPECIES IN GRAND RIVER BASIN



The southern Michigan deer herd is increasing at about 14 percent per year and this herd is expected to approach 80,000 to 90,000 by 1968.

larger hardwood-forested areas, while fox squirrels are abundant in and around farm woodlots and other areas comprising a mixture of timber and open lands. An estimated 170,000 squirrels were harvested annually within the Basin during the early 1960's (Table 3, Column 2). Squirrels ranked third in Basin bag checks during this period. They were the most prevalent species taken in Eaton County.

The snowshoe (varying) hare provides hunting in Basin areas having mixed conifers and hardwoods. These areas occur primarily in portions of Kent and Montcalm Counties. Other isolated populations also are present. Approximately 7,000 snowshoe "rabbits" were killed annually in southern Michigan counties from 1960 through 1965.

The ruffed grouse is a major game bird in certain Basin counties. Estimates showed that nearly 23,000 birds were harvested annually from 1959 to 1963 (Table 3, Column 3). Some Basin areas supported over 30 birds

per 100 land acres (Figure 5-B). Grouse require conifers for winter roosting cover, a not too dense hardwood stand for nesting and food, brushy land for escape cover and berries, sunny openings for dust baths, and insect food for the young.

(2) Farm species. Cottontail rabbits are the most abundant game mammal in the Basin. They are also the most abundant mammal in the hunter's bag in all but one county (Table 3, Column 4). Rabbit production throughout the Basin is directly associated with the less intensively used lowland agricultural areas (Figure 5-C). The 1959 through 1963 average harvest per hunter ranged from 2.6 to 2.9 rabbits in Eaton, Ingham, and Shiawassee Counties to nearly 5.0 rabbits in Montcalm, Jackson, and Barry Counties. The remaining counties fell between 3.0 and 4.0 rabbits per hunter.

The ring-necked pheasant is the major game bird in most Basin counties. Harvest is especially high in portions of Ottawa, Ingham, Shiawassee, and Kent Counties (Table 3, Column 5). An estimated 187,000 pheasants were taken annually in the Basin from 1959 to 1963. The pheasant's range, as estimated by hen counts during the spring of 1961, indicated a very high population in southeastern Ottawa, southwestern Kent, and northeastern Shiawassee Counties (Figure 5-D). Cock pheasant crowing surveys made during May of 1966 (pheasant "crows" heard per two-minute stop) provided indices of pheasant populations (6). Following is the 1966 survey compared to the seven-year average, 1960 through 1966 (in parentheses):

Ottawa	11.9	(8.8)	Montcalm	3.1	(1.8)
Ingham	9.6	(12.2)	Shiawassee	2.5	(7.6)
Clinton	9.6	(7.0)	Gratiot	2.2	(3.5)
Jackson	7.9	(7.2)	Ionia	2.1	(2.0)
Eaton	5.6	(7.2)	Kent	1.0	(2.2)
Barry	4.6	(2.9)			

The 1966 Basin crow-count average was 5.5, only slightly below the seven-year averages of 5.7. Pheasant populations have been declining over nearly the entire midwest and southern Michigan, primarily because of shortages of winter and nesting cover caused by more intensive farming practices and by a change in timing of crop harvesting (7).

The range of huntable populations of bobwhite quail is limited principally to southeastern Michigan. Eaton, Jackson, and Ingham Counties have open season on this game bird. The season is limited to five-days duration.

Woodchucks, badgers, and crows provide "varmint hunting" in the Basin. There are three-month seasons for badgers and woodchucks, but crows are available to the hunter throughout the year.

(3) Furbearers. The red fox and raccoon provide considerable hunting sport for Basin users. Opossum receive some minor hunting pressure. Other furbearers are seldom hunted with dog or gun. The status of trapping is a question of values. It is considered a sport by some, and a business by others. Trapper harvest estimates for mink and muskrat, and hunter and trapper harvest estimates for raccoon are given in Table 3, Columns 6, 7, and 8. Skunk, weasel, beaver, and otter are also trapped in the Basin, but not to the extent that muskrat, mink, and raccoon are harvested. Average prices received per pelt by southern Michigan trappers during the early 1960's ranged from $12 for mink to $0.40 for an opossum.

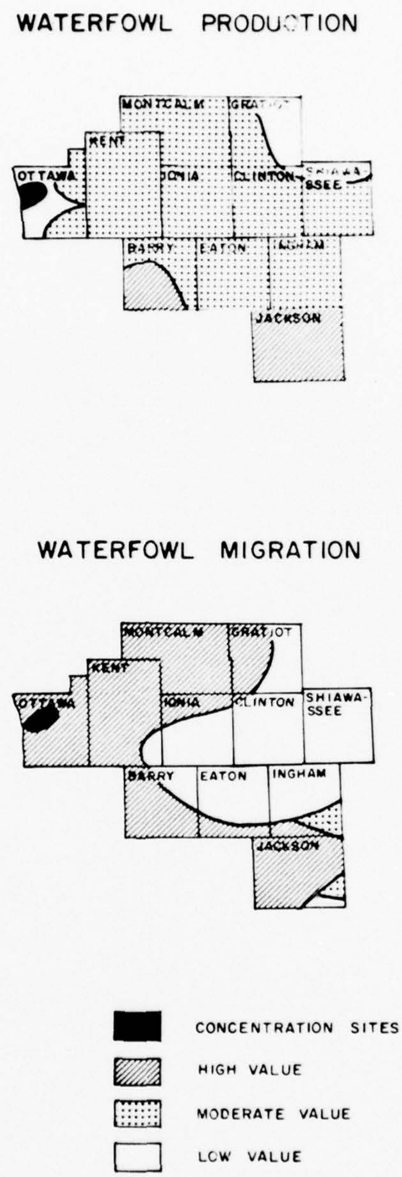
(4) Migratory birds. The majority of waterfowl originating from, or passing through, the Grand River Basin during the fall migration are bound for the Mississippi Flyway. Some scattered flocks in the eastern portion of the Basin branch off to the Atlantic Flyway. Mallards, black ducks, and blue-winged teal comprise three-fourths of the breeding ducks in southern Michigan. Wood ducks are next in abundance, followed by ring-necked ducks, mergansers, pintails, and goldeneyes (8/95). Major Basin concentration sites for waterfowl production occur near the Grand River's junction with Lake Michigan (Figure 6). Other areas having high value for waterfowl production occur in southern and western Barry County and the majority of Jackson County. The Grand River in Ottawa, Kent, and Ionia Counties; the Flat River in Ionia and Kent Counties; the Maple River in Gratiot and Clinton Counties; the Looking Glass River in Ionia, Clinton, and Shiawassee Counties; and the Gratiot-Saginaw Counties State Game Areas all harbor concentrations of waterfowl. An inventory of public and private lands and waters significant to waterfowl (9) appears in Table 4, Column 1. These tabular figures do not show the varying quality of waterfowl habitat.

Estimated harvest of geese, ducks, and coots from 1959 through 1962 averaged over 28,000 annually (Table 3, Column 9). Counties having highest kill figures, which reflect fall population densities and hunting opportunities, were Ottawa, Kent, and Jackson.

Nearly 10,000 woodcock were taken annually throughout the Basin during the early 1960's (Table 3, Column 10). Highest woodcock populations occur in the western Basin counties (Ottawa, Kent, Montcalm, Barry) and Gratiot County in the northeast. This migratory game bird is associated with moist, alder lowlands, where it finds abundant supplies of earthworms. Wilson's snipe, rails, and gallinules are also hunted in the Basin's marsh areas.

The mourning dove is not legal game although it is plentiful throughout the Basin. The dove breeding population, as determined from a call index ("coo-count"), increased regularly from 1953 through 1960. In 1960 the estimated population (775,000) had more than doubled over that

FIGURE 6. WATERFOWL PRODUCTION AND MIGRATION IN GRAND RIVER BASIN, MICHIGAN - 1954 (Panzner)



occurring throughout the State in 1953 (10). A population which could readily support a hunting season is now available in southern Michigan.

15. UNIQUE NATURAL AREAS

Areas harboring relict systems of unique plants and animals are increasingly endangered by the advances of our civilization. Such natural areas are not consistently surviving the demands of society.

Areas harboring relict systems of unique plants and animals are increasingly endangered by the advances of our civilization, as illustrated by this abandoned eagle's nest.

Recent years have seen an increasing concern for the preservation of these natural areas. Cain (11) in commenting on a proposal to inventory unique areas states:

> "This systematic national action may avoid the complete destruction - the irreparable loss - of even a single type of natural ecosystem. In many places this is a race with the developers - the road and dam builders, the suburban developers, the dredgers and fillers of wetlands - but in most cases there is yet time to see that some relict is saved".

Areas possessing this vanishing habitat are numerous throughout the Grand River Basin. Resource planners must consider these remaining ecological systems if this study is to be truly comprehensive. Some Basin areas are already in public ownership or responsible private ownership. The Michigan State Game Areas, Parks, and Recreational Areas presently provide the majority of the public control. County and municipal park boards are in an excellent position to expand their program to suitable areas.

Educational institutions and wildlife societies have shown keen interest in specific Basin areas which possess unique habitat for diminishing or rare species of plants and animals. The Michigan Natural Areas Council, an organization concerned with the preservation of natural areas in Michigan, is interested in several areas within the Grand River Basin. The Kalamazoo Nature Center, Michigan Audubon Society, and other groups also are working for preservation of natural areas to be used for nature study and allied pursuits. Educational Institutions using Basin areas for field study include Michigan University, Michigan State University, Cranebrook Institute of Science, Olivet College, Hillsdale College, Albion College, Western Michigan University, and others.

With multiplicity of organizations interested in protecting natural areas, it is imperative that a comprehensive study system be developed for thorough and orderly establishment of reserves. The Conservation of Ecosystems Subcommittee, to the International Biological Program, has made the most significant movement for developing such a program in the United States. This group will ask local specialists to assist in locating, describing, and justifying the establishment of areas. Not all needed reserves can be established at once. Consequently, a system of priorities, with appropriate criteria, has been proposed as follows (12/21):

Criteria	Areas Affected
Degree of threat - - - -	Habitat types imminently threatened by destruction or damage.

Criteria (con't.)	Areas Affected (con't.)
Uniqueness	Areas representing unique habitat types or containing unique species.
Rarity	Areas representing rare habitat types that are unprotected or insufficiently represented in existing reserves.
Completeness	Areas representing habitat types not included in the existing reserve system; inclusion needed to insure that the system provides complete coverage.
Research needs	Areas required to protect examples of habitat types sufficiently large or numerous to satisfy need for research that involves manipulation and research confined to observation.
Unusual scientific	Areas having some special value for scientific purposes - for example, areas showing unusual juxtaposition or combinations of habitat types, or areas having a long history of sound research, or areas particularly suitable as research facilities because of ease of access or a comparable attribute.
Typicalness	Areas that are representative of other widely spread ecosystems.

Some of the areas now existing within or near the Basin (Table 5), other than State areas, include the Haehnle Audubon Bird Sanctuary in Jackson County and Baker Audubon Bird Sanctuary in Calhoun County (both of value for waterfowl and as some of the best remaining nesting sites for the greater sandhill crane) and the Pitchfork Valley Wildfowl Trust in southern Barry County (has multiple unique plant and animal communities). Also available are unique areas in and near the Waterloo Recreation Area in Jackson County and the Yankee Springs Area in Barry County. The Newaygo dry prairie area extending into northwestern Montcalm County and the flats along the Maple, Looking Glass, and Grand Rivers provide a wide range of diminishing habitat types. Indian Creek in Eaton and Calhoun Counties is important as a field study area.

During the early 1900's the Grand and Maple Rivers were the major mussel shell producing streams in Michigan. In this period of extensive commercial mussel harvesting throughout the Midwest, over 400 tons annually

were taken from the two streams. A small portion of this unique resource still exists in the Grand River east of Grand Rapids. This stretch in the Grand River between Muir and Comstock Park is reasonably clean and represents one of the few large-river regions within the Lower Peninsula of Michigan that is productive of fresh-water mussels, although commercial harvesting was discontinued many years ago.

The Grand River Basin also possesses many species of champion-sized trees as listed by the Big Tree Committee of the Michigan Botanical Club (13). They list 12 trees of State record; of which nine are said to be the largest found within the Nation (Table 5).

16. UTILIZATION OF FISH AND WILDLIFE RESOURCES

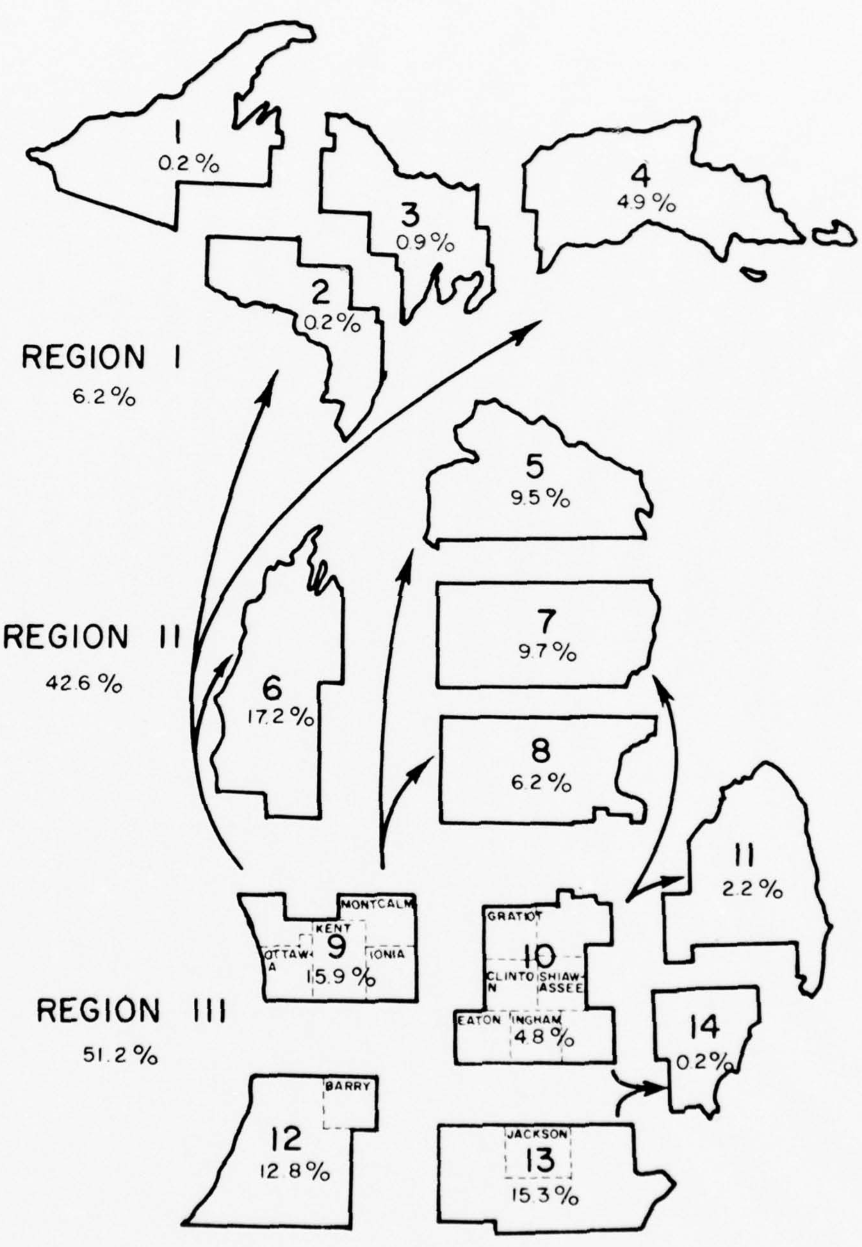
a. Origins and destinations. Determinations of hunter- and fisherman-travel patterns are extremely important for proper evaluation of demand estimates, and ultimately for proper planning to meet estimated demands. An area generating high demand may lack the necessary ingredients to sustain the demand locally. Similarly, tradition or habits may be an important determinant of travel patterns. This being the case, those creating the demand may travel out of their area of residence to an adjacent or even far removed area where opportunity or satisfaction is available. Plans, therefore, must be geared to the particular area where demands can most conveniently be met, not necessarily to the area where the demand originates.

Using data gathered by the Michigan Department of Conservation and analyzed by the Michigan Outdoor Recreation Demand Study (14), estimates of Grand River Basin ingress and egress were calculated to provide indices as to magnitude of the endogenous and exogenous demands for hunting and fishing in the Basin.

(1) Fishing. The 1964 Michigan General Creel Census was used for analysis of angler origins and destinations. Although information gathered from this study was neither designed nor ideally suited for this type of analysis, it is the best source of fisherman data available. Over the entire state, approximately 59,000 fishermen, including 8,000 non-resident anglers, were interviewed by Conservation Officers during the spring, summer, and fall months of 1964. Although 90% of Michigan's population lives in Region III, only about 52% of all anglers interviewed resided in this area. Approximately 19% were from Region II, 16% from Region I, and 13% from out-of-state (See Figure 7 for definition of regions and districts).

Nearly twice as many people reside in Region II than Region I. These related percentages between user origin, population densities, and the effect of available opportunity will be discussed in the projective methodology portion of the report. The number of users is very much

FIGURE 7. DESTINATION OF ANGLERS FROM DISTRICTS 9, 10, 12, AND 13 (1964)



dependent upon the number of people residing within an area and the opportunity available to the prospective angler.

Department of Conservation administrative Districts 9, 10, 12, and 13 include all counties within the Grand River Basin study area. Nearly 28 percent (16,244 anglers) of all resident anglers interviewed throughout the State resided within these four southwestern Michigan districts.

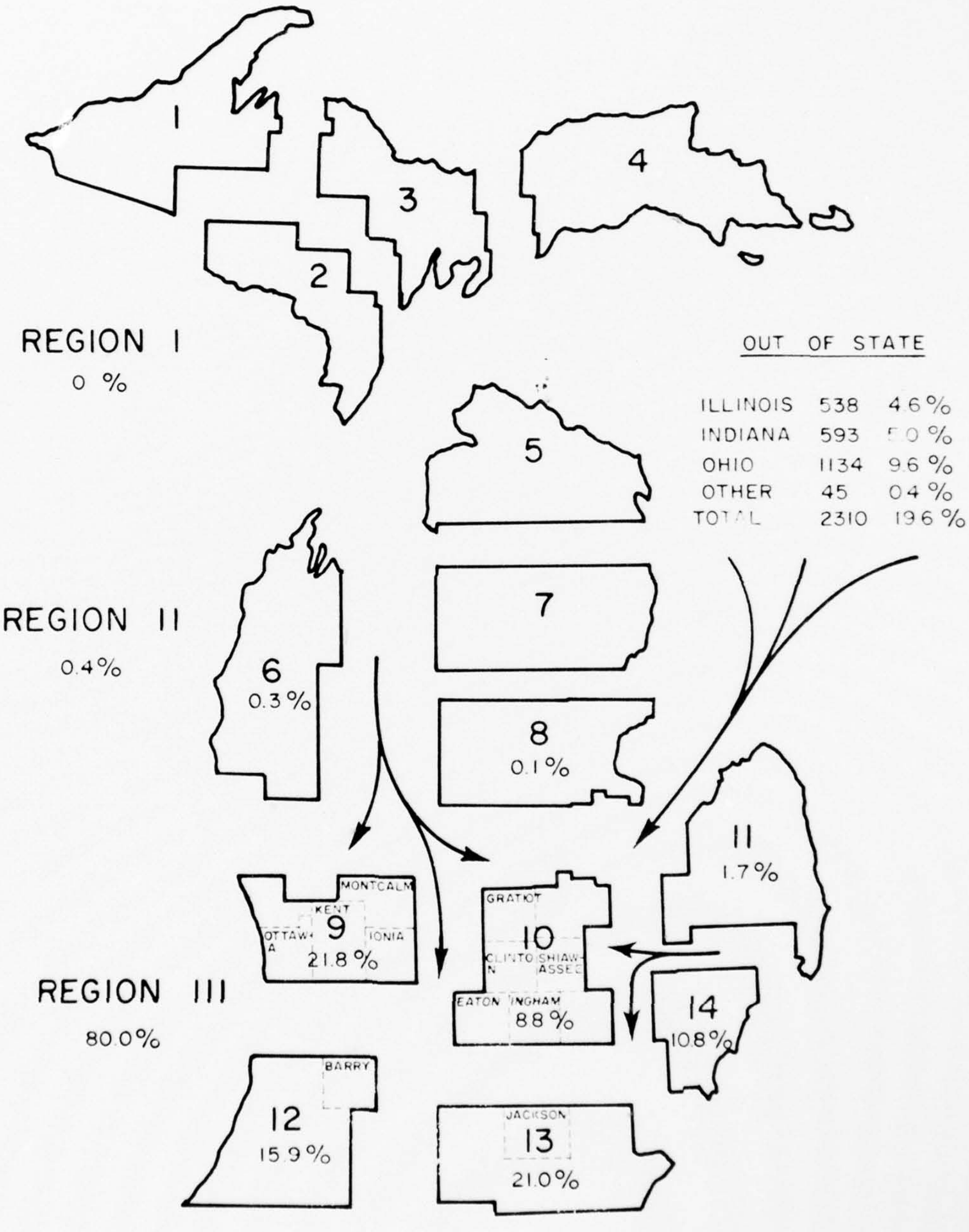
Figure 7 represents the destinations of these southwestern Michigan anglers. Approximately one-half of them were fishing within the four-district area. Surprisingly, more anglers were interviewed in District 6 than any other district, including the Grand River Basin Districts. Of all anglers interviewed (resident and non-resident), Region II received the heaviest use, 43%, followed by Region III - 33%, and Region I - 24%. Although nearly 28% of all resident anglers came from Grand River Basin districts, only 21% of resident and non-resident anglers interviewed were using the Basin area. Thus, there was a net egress from the Basin, assuming that most Basin residents did not go southwest within the State when they travelled outside of the Basin.

Interviewees using Grand River Basin districts came from 8 districts and several other states (Figure 8). Of the 11,768 anglers interviewed within the Basin districts, about 68 percent were actually from these districts.

These combined data showed that many Grand River Basin residents were willing or had to travel outside of the Basin area (almost exclusively north) to enjoy their particular angling recreation. Basin use by non-residents from neighboring southern states and residents from the Detroit metropolitan area netted-out a portion of this outward movement. However, not all Basin subareas had a net angler egress travel pattern.

The West Central Belt Subarea (Montcalm, Ionia, and Barry) and Jackson Subarea indicated net gains of fisherman use. Use of subarea resources was 104% of demand generated by subarea residents in the West Central Belt Subarea and 167% in the Jackson Subarea. Both of these subareas had above average available fishing opportunity (measured by acres of fishing habitat per capita), when compared to other subareas (Table 1, Column 4), and both were near major highways which carry southern non-resident users into Michigan. Jackson Subarea received non-subarea fishing pressure primarily from Detroit and Ohio; the West Central Belt Subarea received use from the Grand Rapids Subarea, Indiana, and Illinois. The Grand Rapids (40%), Lansing (58%), and Northeast Fringe (69%) Subareas had less use within the subarea than fishing demands generated by subarea residents. The main angler migration from the Grand Rapids Subarea was correlated to the high population density and, to a lesser extent, to a below average amount of fishing opportunity per capita. The urban dweller also tended to be more mobile than the rural resident. The comparative mobility of the urban and rural inhabitants was apparent

FIGURE 8. ORIGIN OF ANGLERS USING DISTRICTS 9, 10, 12, AND 13 (1964)



in the rural Northeast Fringe Subarea. Even though fishing opportunity (acres of fishing habitat per capita) is below the Basin average, many subarea residents apparently prefer what is present near their home rather than using facilities outside of the subarea. This behavior pattern was not as apparent in the more urban Lansing Subarea.

(2) Hunting. The 1964 Michigan Small Game Hunter Participation Survey (15) and similar data gathered from the 1964 deer hunting season were used for estimating origins and destinations of hunting pressure. Questionnaires were sent to a sample of small game and big game license holders. Their replies formed the basis for the Department of Conservation's analyses of hunter distribution, effort, and success.

The supply, including habitat and game, was generally located in the Upper Peninsula (Region I) and the Northern Lower Peninsula (Region II). As a result of the large demand generated in Region III, many southern Michigan hunters travelled north. Region III deer hunters travelled further than did small game hunters:

	Deer		Small Game	
Region	Origin	Destination	Origin	Destination
I	8.8%	20.0%	7.3%	11.4%
II	19.5	66.5	12.2	24.4
III	69.8	13.5	79.3	64.2
Non-Resident	1.9		1.2	

The districts containing Grand River Basin counties (9, 10, 12, and 13) contributed 38.8 percent of the total Michigan deer hunting effort. Conversely, Grand River Basin districts supplied only 11.8 percent of the total deer hunting pressure.

Considering only deer hunters surveyed from these four districts, 28.7 percent of their hunting efforts were satisfied within the 4-district area (Figure 9). Nearly all of the remaining Basin deer hunting effort occurred in Regions I and II. Districts 6, 7, and 8 each received more deer hunting pressure from Grand River Basin district residents than did any of the Basin districts.

That deer hunting pressure in the 4-district area in 1964, came almost exclusively (93.6 percent) from residents of those districts (Figure 10). Of the remaining deer hunting pressure within this area, most came from Districts 11 and 14, the remaining Region III districts.

Small game hunters did not travel as far as deer hunters to enjoy their sport. The Grand River Basin small game hunter exerted much of his

FIGURE 9. DESTINATION OF DEER HUNTING EFFORT FROM DISTRICTS 9, 10, 12, AND 13 (1964)

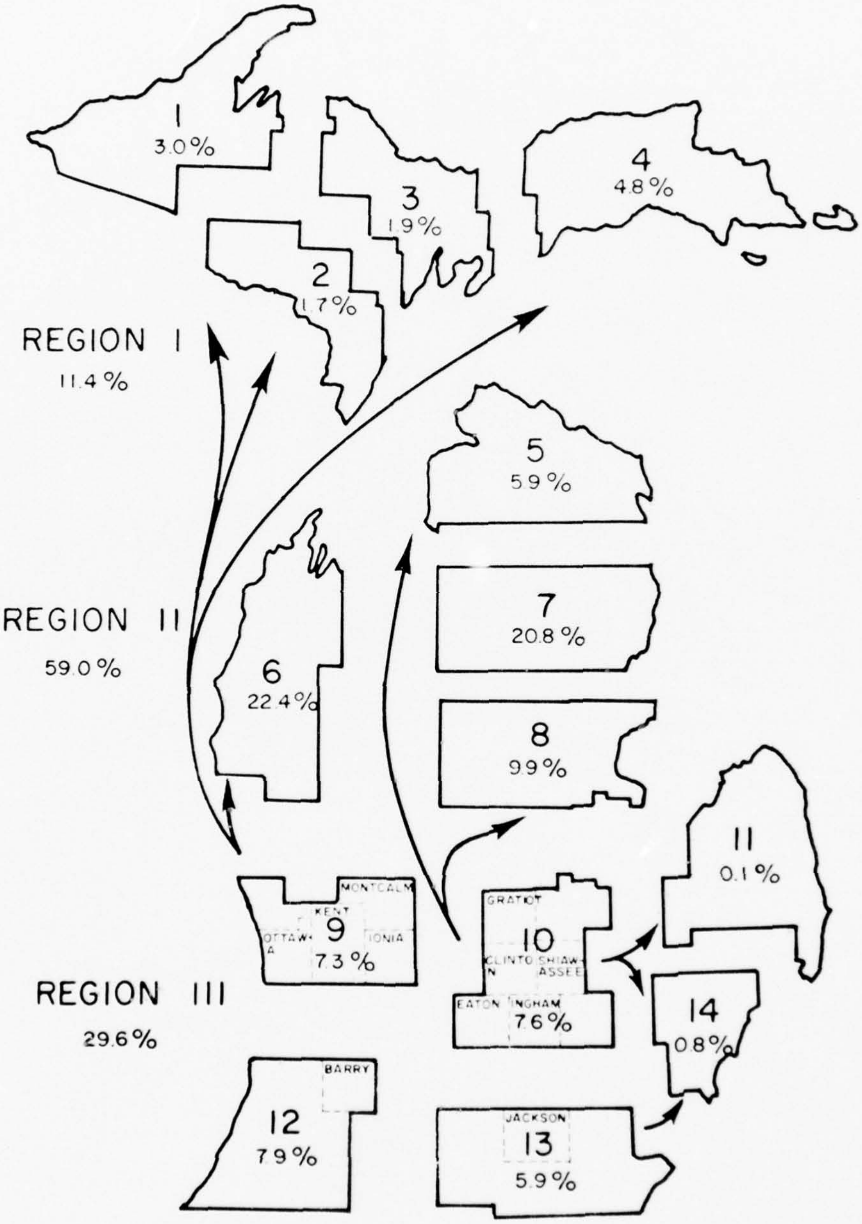
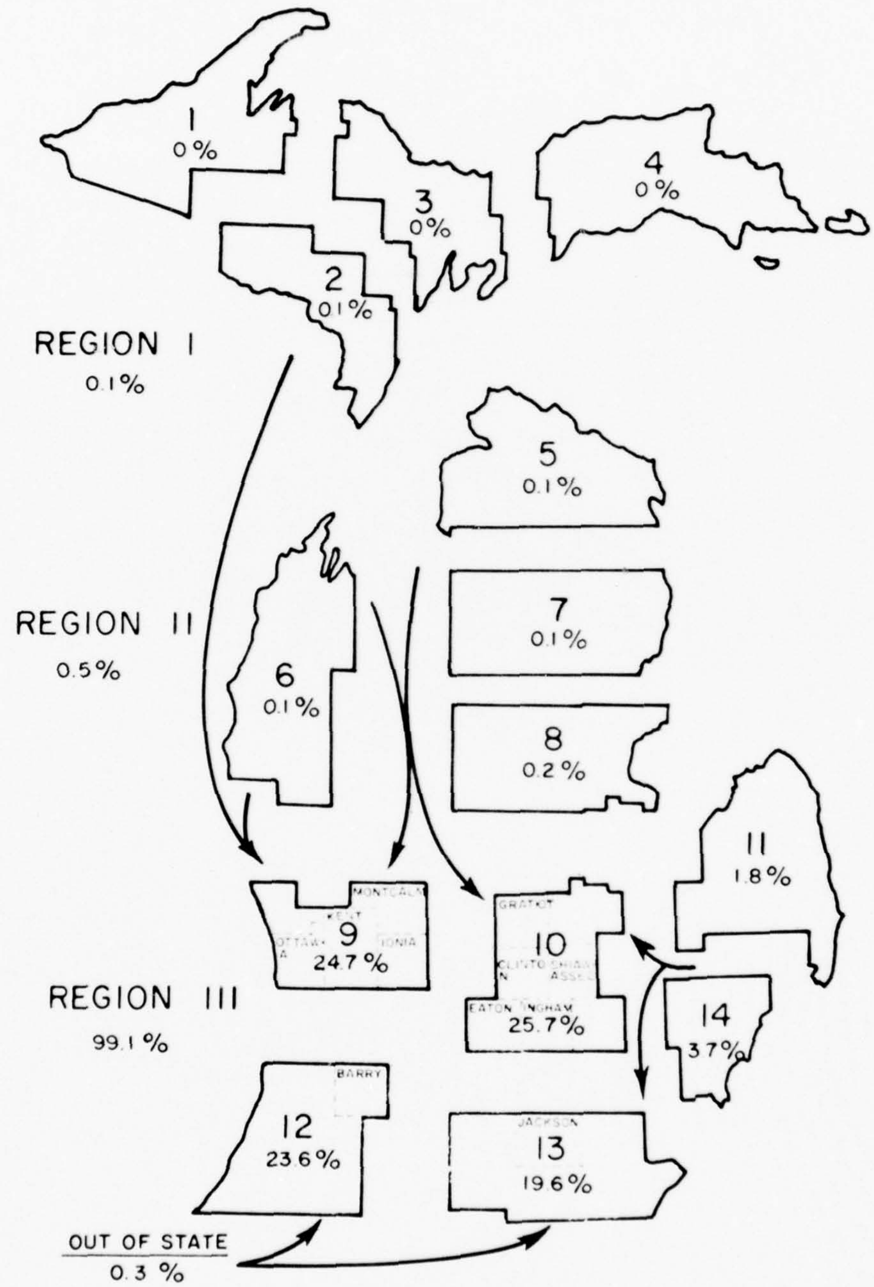


FIGURE 10. ORIGIN OF DEER HUNTING EFFORT IN DISTRICTS 9, 10, 12, AND 13 (1964)



hunting pressure within the Basin. Approximately 40% of the total Michigan small game hunting effort originated from the four Basin districts, and nearly 43% of the total State pressure occurred within this area (15). There was, therefore, a small net influx of small game hunting effort into the four districts.

Over 85 percent of the effort expended by small game hunters who lived in Districts 9, 10, 12, and 13, occurred in these districts during 1964. The remaining 15 percent dispersed as shown by Figure 11. Figure 12 shows that over 87 percent of the total small game hunting effort within the 4-district area, came from residents of that area. The remainder came primarily from Districts 11 and 14.

Considering the sum of Basin deer and small game hunting effort, about 84 percent of the demand generated by Basin residents actually occurs within the Basin. This figure reflects the egress of Basin deer hunting demand, dampened by the influx of small game hunting demand into the Basin.

Only the West Central Belt Subarea (Montcalm, Ionia, and Barry) indicated net gains of deer and small game hunter use (subarea ingress exceeded subarea egress). If 100% indicates that subarea egress equals subarea ingress, then the subareas have the following net gain or loss percentages: Grand Rapids - 68.4%, West Central Belt - 138.0%, Lansing - 81.4%, Northeast Fringe - 81.4%, and Jackson - 77.3%. These figures are related to opportunity as shown by acres of huntable land per capita (Table 4, Column 5). Many of the factors evident in the analysis of fishermen origins and destinations are also pertinent factors for hunter distributions. The primary difference between hunter and fisherman travel patterns is the more adequate small game opportunities to Basin users. The majority of the movement out of the Basin is for coldwater fishing opportunity, remote warmwater fishing opportunity, or the opportunity to hunt deer in more remote areas.

b. License sales.

(1) Fishing. Approximately 140,000 residents of the Grand River Basin bought fishing licenses in 1960 (Table 1, Column 5). An additional 64,000 individuals fished, but were not required to buy licenses because of sex, age, or other reasons. Thus, approximately 203,000 anglers from the Grand River Basin fished in 1960 (Table 1, Column 6). However, because of Basin ingress-egress patterns, only about 147,000 anglers used the Basin in 1960 (Table 1, Column 7).

Over 27,400 Basin residents bought trout stamps in 1960, or 1 out of every 5 who bought a resident fishing license. An estimate of anglers fishing in Lake Michigan was difficult to determine. Licenses are not required for residents to fish in the Great Lakes; and non-residents

FIGURE 11. DESTINATION OF SMALL GAME HUNTING EFFORT FROM DISTRICTS 9, 10, 12, AND 13 (1964)

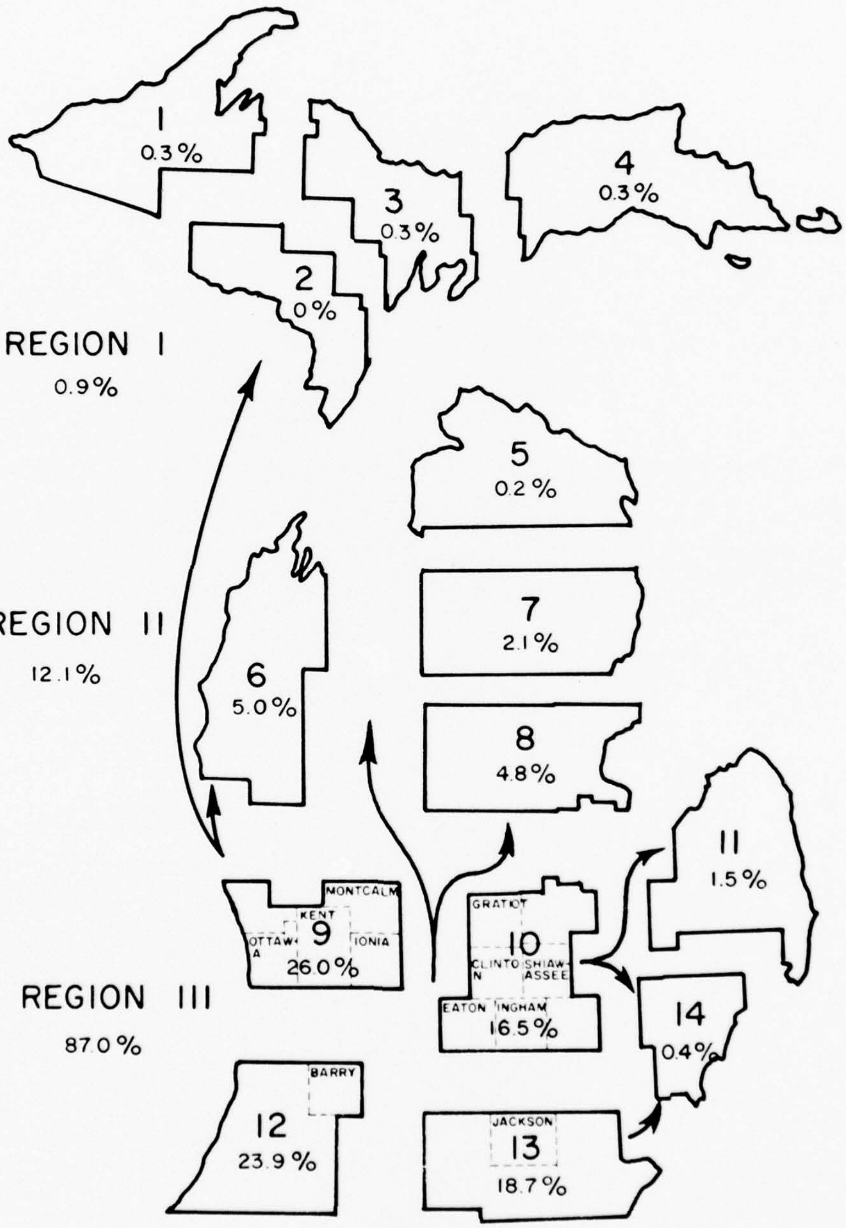
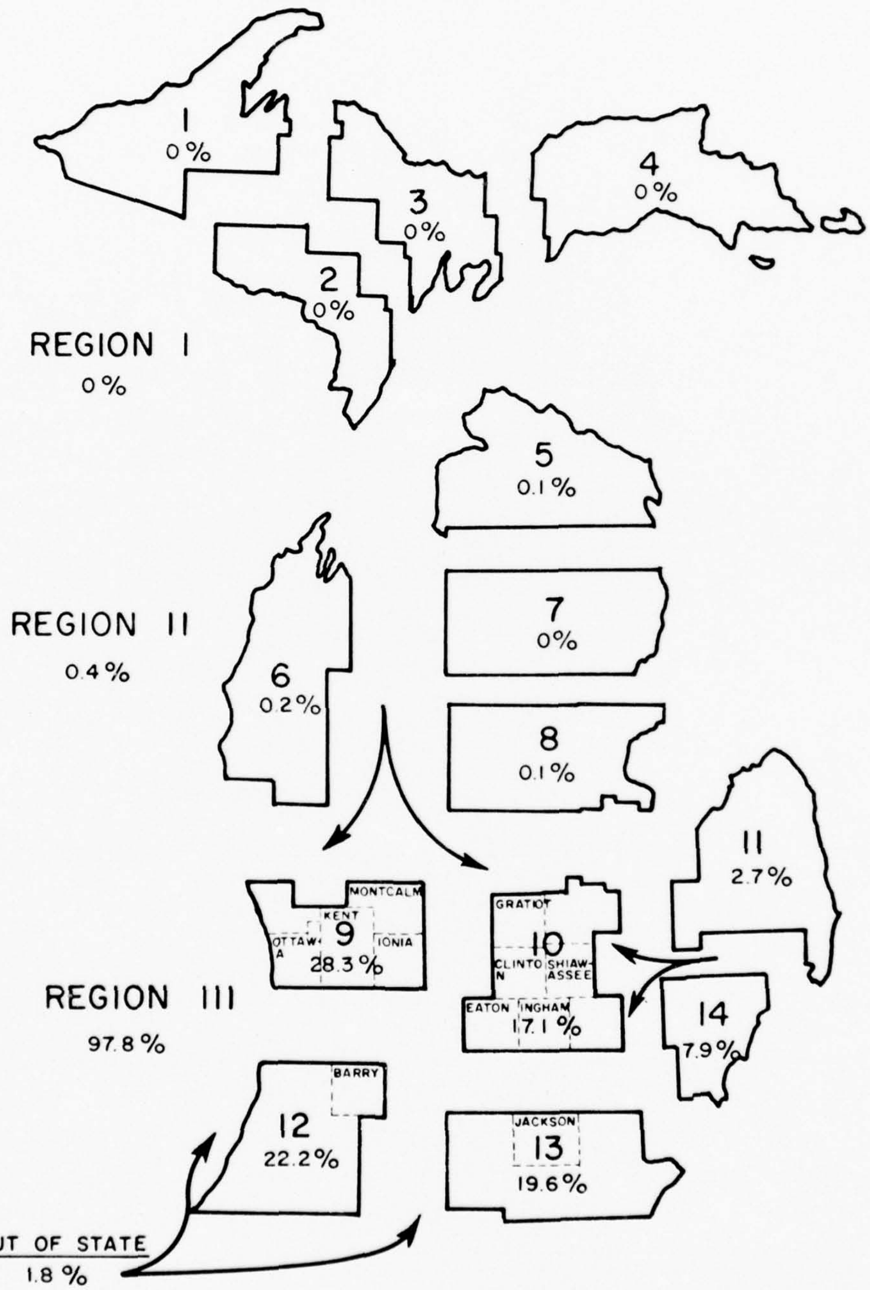


FIGURE 12. ORIGIN OF SMALL GAME HUNTING EFFORT IN DISTRICTS 9, 10, 12 AND 13 (1964)



are not required to buy licenses to fish in the Great Lakes if they seek yellow perch, catfish, bullheads, blue pike, saugers, ciscoes, or carp.

(2) Hunting. Over 145,000 licensed hunters resided within the Basin in 1960 (Table 4, Column 6). These Basin hunters bought approximately 113,000 small game licenses; 76,000 (gun) deer licenses; and 5,000 (bow and arrow) deer licenses in 1960. Total license sales from Basin residents were about 194,000. However, since some individuals buy more than one type of hunting license (average of 1 1/3 licenses per hunter), this total had to be reduced by 25%, resulting in a total of approximately 145,000 individual licensed hunters. This group, plus unlicensed hunters, totaled 175,000 hunters originating from the Basin in 1960 (Table 4, Column 7). Ingress-egress patterns reduced the total number of hunters using the Basin to about 147,000 (Table 4, Column 8).

c. Species utilization. Species composition in the fisherman's creel and hunter's bag was analysed previously in this report (Tables 2 and 3). Estimates of fishing or hunting pressure placed on species give another view of the outdoorman's fishing or hunting preference. Estimates of species utilization by hunters are more obvious than fishermen species preference. The hunter pursuing a deer needs a special license, as does the angler who is fishing for trout. However, it is relatively easy to separate upland hunters from waterfowl hunters or squirrel hunters from pheasant hunters by the area of contact and by the equipment in use at the time of contact. The angler on a warmwater lake or stream presents a more complex problem because it is difficult to determine if he is after a particular species. Often, he is fishing for anything that may bite.

(1) Fishing. In comparing trout to non-trout waters, 12-15 percent of the total anglers sampled within the State of Michigan from 1953 through 1962 were interviewed on trout waters (16). As Reed and Needy (14/9.61) pointed out, this percentage in the Statewide creel census is more significant than the ratio of trout stamps to license holders, because unlicensed anglers are included in the interviewed creel census sample. However, in comparing the 27,400 Basin resident trout stamps in 1960 to the estimated 203,000 anglers who were residents of the Basin in 1960, an estimated 13.5 percent were trout fishermen, which compares favorably with figures derived from the Statewide creel census sample. The 1960 Statewide average was approximately 14.5 percent.

The success of the angler throughout the State was consistently higher for Great Lakes waters than for inland waters. Fukano (16) showed that from 1953-62, anglers caught, on an average, 2.2 fish per hour in the Great Lakes, 1.2 fish per hour in inland non-trout waters, and 0.7 fish per hour in trout waters.

At the present time, commercial fisheries activity in the Grand Basin is limited to the fishing ports of Holland and Grand Haven on Lake Michigan. In 1964, landings at the two totaled 219,000 pounds valued at $40,500. The primary species landed were yellow perch, chubs, and whitefish. Some 27 fishermen were active during the year.

In addition to the vessel fishery, some commercial fishing with haul seines is carried out on several inland lakes. Fishermen operate under contract from the Michigan Conservation Department in cooperation with local sportsmen's groups. The main species involved is carp. In 1966, over 100,000 pounds of carp were removed from Spring Lake, located off the Grand River near Ferrysburg. Carp seining has also been reported in Lake Macatawa near Holland. Both of these lakes are in Ottawa County.

(2) Hunting. Ryel (15) showed the distribution of small game hunting effort by species in 1964. In the southern Lower Peninsula (Region III), 87 percent of license holders hunted pheasants. Cottontails were hunted by 67% of all Region III small game hunters, 49% hunted

In the southern Lower Peninsula, 87 percent of the license holders hunted pheasants.

squirrels, and 24% hunted ruffed grouse. Other small game species receiving significant pressure by hunters included, ducks - 16%, woodcock - 12%, snowshoe "rabbits" - 9%, and raccoon - 8%.

Hawn (17) developed statistics for the 1965 small-game hunting-season showing hunters and hunter-days exerted against various popular species on a Statewide basis. Hunters showed similar trends as displayed in Ryel's 1964 report. Despite the fact that there were more pheasant hunters within the State than rabbit hunters, greater numbers of hunter days were exerted against the cottontail. Hunter-day use showed the following Statewide ranking of effort expended: cotton-tails, pheasants, squirrels, ruffed grouse, snowshoe "rabbits", ducks, woodcock, raccoon, and geese.

Deer receive the greatest hunter-day use of any species on a Statewide basis. As shown in the Origin-Destination Section, only about 30 percent of the deer hunting pressure exerted by Basin residents actually occurs within the Basin.

d. Habitat utilization.

(1) Fishery habitat. In 1960, stream fishing pressure within the Basin was estimated to range from 59 anglers per fishable stream mile in Ottawa County to 79 in the streams predominated by quality fisheries of Barry County (Table 1, Column 8). The Basin mean for all types of fishable streams was 72 man-days use per mile. Basin warmwater stream use averaged about 54 man days per fishable mile, while trout stream fishing amounted to 175 days-use per mile throughout the Basin. Indications are that during the past 10 years approximately 10 - 15 percent of the warmwater anglers in Michigan were stream fishermen (14/9.61). During the same period, approximately 75 percent of the State's trout fishermen preferred streams rather than trout ponds or lakes (14/9.61).

Fishing on the Basin's ponded waters, including natural lakes, larger impoundments, and farm ponds, averaged 24 man-days use per acre and ranged from 29 in Jackson County to 19 in several counties (Table 1, Column 9). This range is affected by the quality of the fishery and the size of the body of water. Farm ponds, averaging ½-acre in size, had average usage of 47 angler-days use per acre. Use figures, analysed from 47 natural lakes and larger impoundments in Illinois, Indiana, and Ohio, averaged 27 angler-days use per acre for 500-acre waters and 20 for 1000-acre lakes. *

* Data on file in River Basin Studies Ohio Area Office, Lebanon, Ohio.

The historical rights of the public to use the waters of a particular State is a question of legislative interpretation, usually only settled conclusively by judicial determination. In Michigan, the right of the public to boat and fish upon all waters which are navigable in fact has been well-established through decisions of the State Supreme Court. However, the opportunity to exercise the right to boat and fish is dependent on the availability of access without trespass. Therefore, access is an important determinant of water habitat use. Many miles of stream and acres of ponded water, which otherwise would have been unavailable to public use, have been made available through State purchase of water access sites. By 1966, public access was available to approximately 70 percent of the total Basin water acreage. Of the acres inaccessible to the public, the Michigan Department of Conservation estimates that about 6,300 acres or 13 percent have immediate need for access developments. The State of Michigan has presently developed access sites at 47 Basin lakes, comprising nearly 14,700 acres of water, and on five Basin rivers. There were four sites in Ottawa County and eight in Kent County (Figure 13); 15 in Montcalm County, two in Ionia County, and 16 in Barry County (Figure 14); two in Clinton County (Figure 15); one in Gratiot County (Figure 16); and four in Jackson County (Figure 17). Each of these sites had a boat launching ramp and parking facilities. There were also other access sites available at privately owned camps and boat liveries, providing public access to varying degrees.

Figures 13 through 17 also denote trout streams, smallmouth bass streams, and walleye streams which were open partially or entirely to the angler.

(2) Game habitat. Private lands which are potentially huntable total about 3,880,000 acres and represent 96 percent of all huntable lands within the Basin (Table 4, Columns 3 and 4). Hunting pressure on private lands has been estimated to support approximately 0.3 hunter-days use per acre. The Basin mean for hunter-days use per acre for all hunting lands, which includes public hunting acres, was estimated to be 0.36 (Table 4, Column 9). This annual figure ranged from 0.33 hunter-days use per acre in Ottawa and Eaton Counties to 0.40 in Barry County.

Gordinier (18) states that 100 acres of private land supported 65 man hours of use in 1960. This report, unlike Gordinier's, uses hunter-days use per acre for a comparative figure, rather than man hours per acre, because of the problems associated with different lengths of hunts for various species of game.

There were about 164,000 acres of lands and waters suitable for waterfowl hunting within the Basin in 1960 (Table 4, Column 1). Nearly all of this acreage was in private ownership. It was estimated that these acres were used at a rate of 0.62 waterfowl-hunter days per acre.

FIGURE 13. GRAND RAPIDS SUBAREA FACILITIES MAP

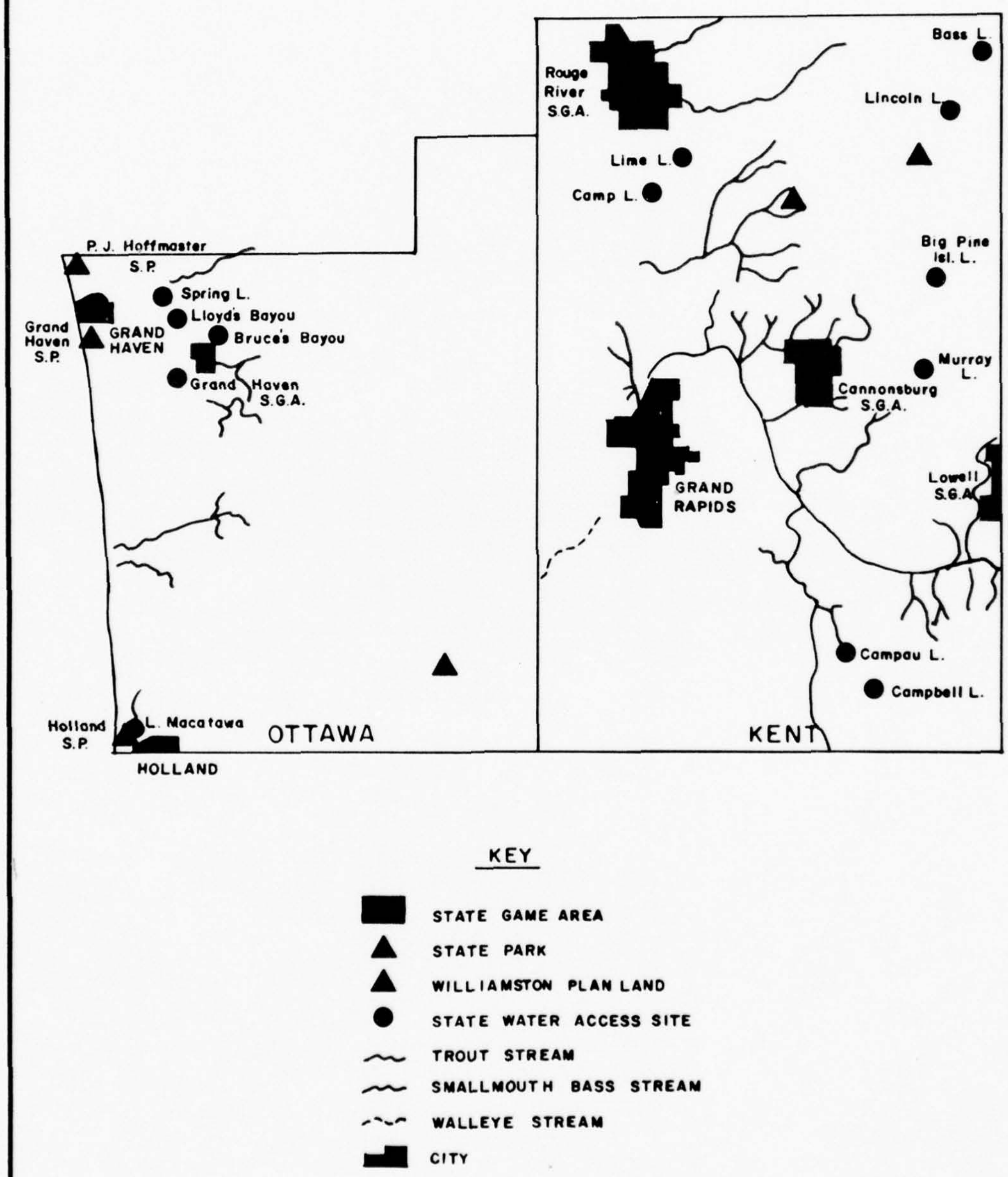


FIGURE 14. WEST CENTRAL BELT SUBAREA FACILITIES MAP

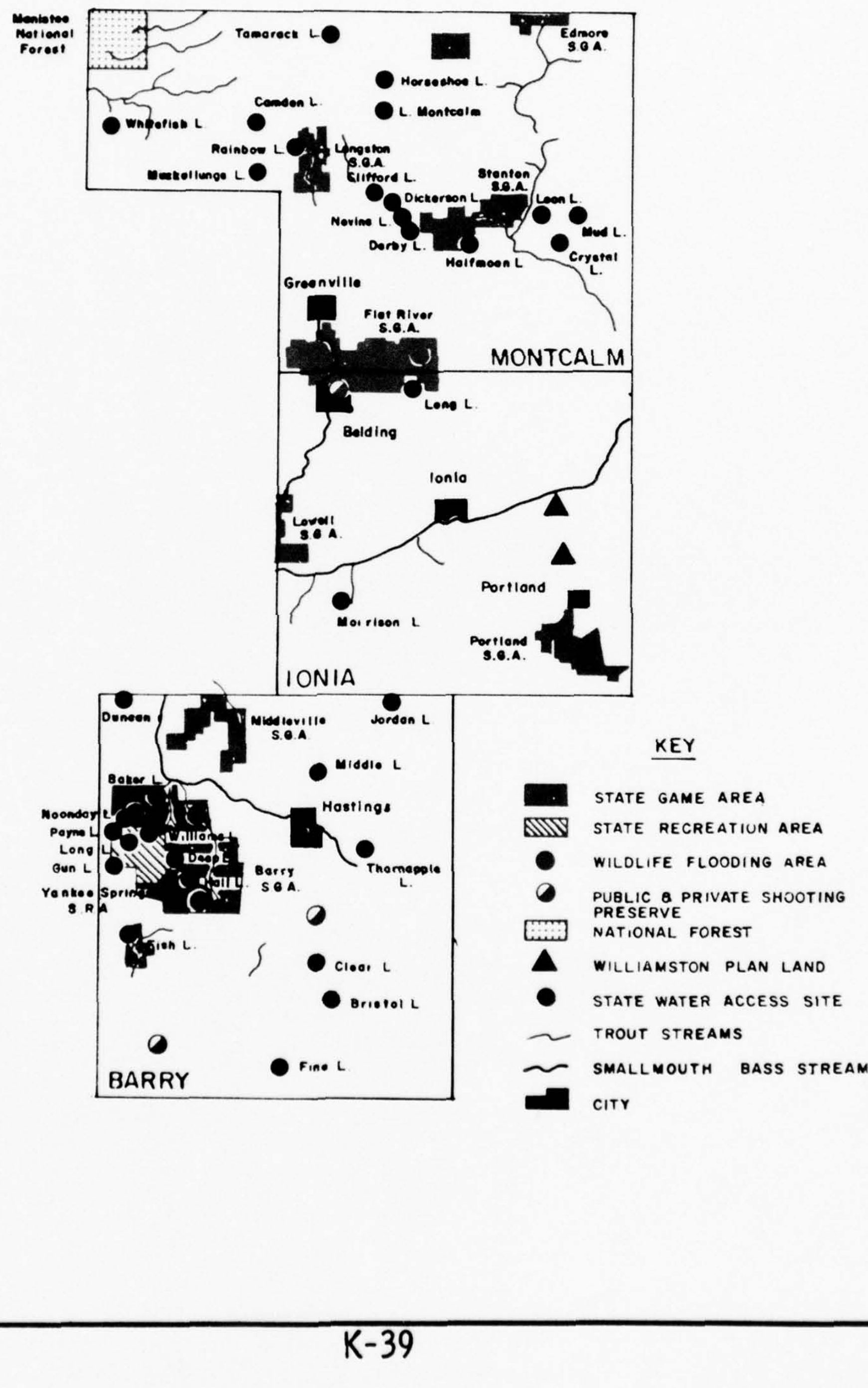
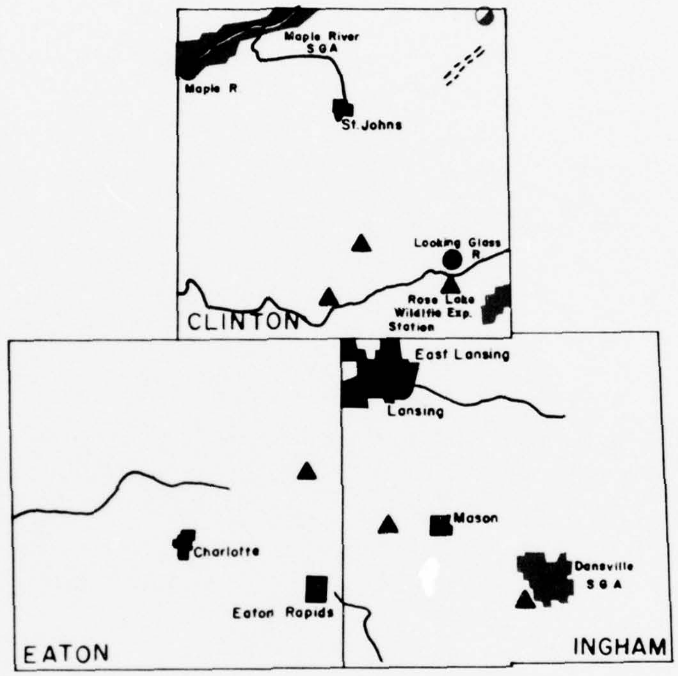


FIGURE 15. LANSING SUBAREA FACILITIES MAP



KEY

- STATE GAME AREA
- PUBLIC AND PRIVATE SHOOTING PRESERVE
- WILLIAMSTON PLAN LAND
- STATE WATER ACCESS SITE
- SMALLMOUTH BASS STREAM
- WALLEYE STREAM
- CITY

FIGURE 16. NORTHEAST FRINGE SUBAREA FACILITIES MAP

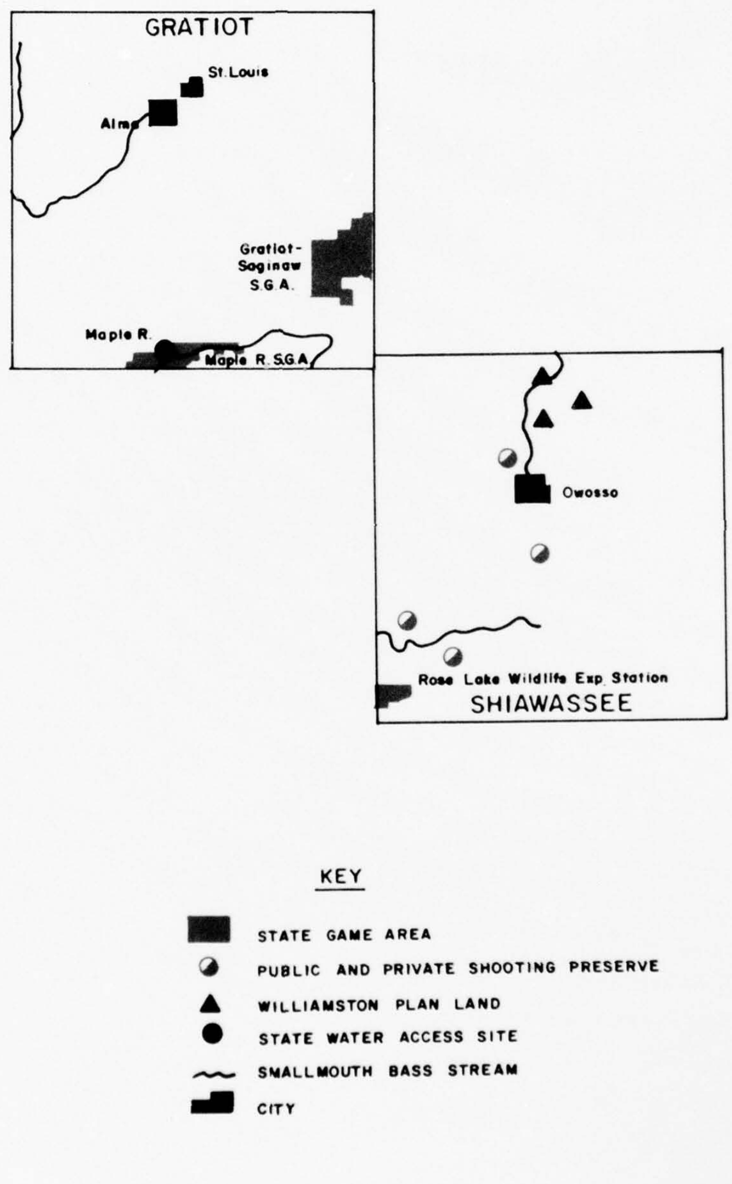
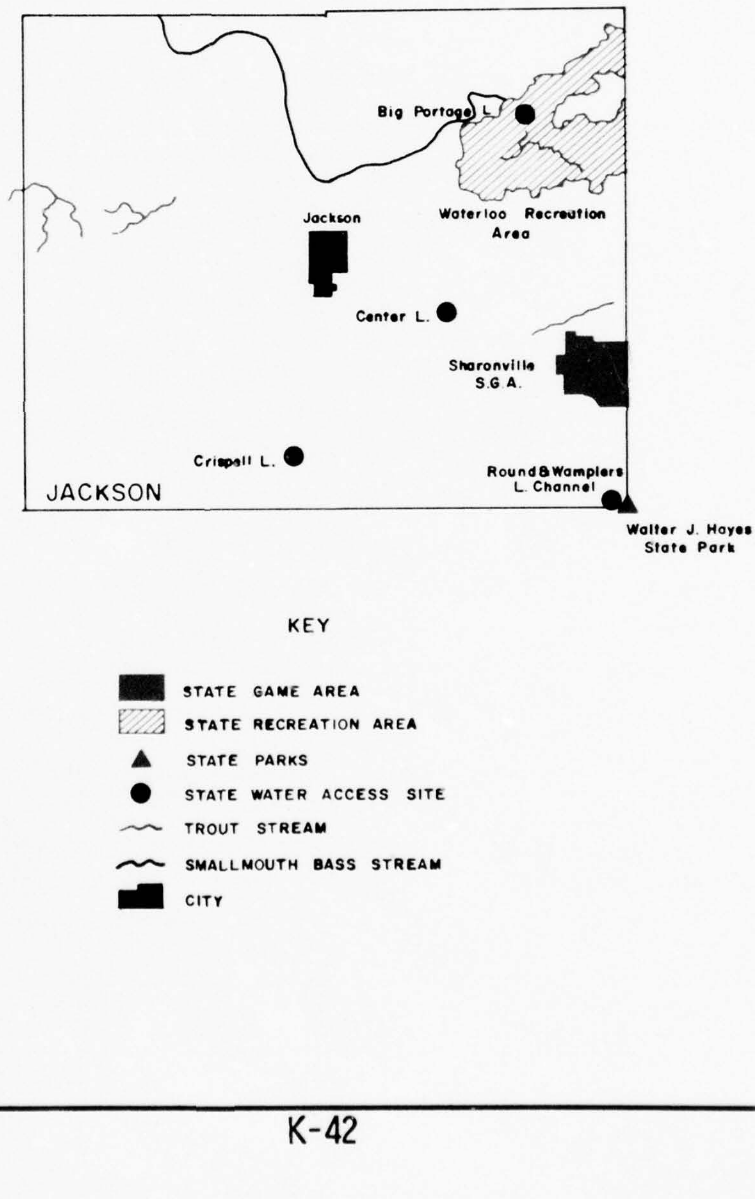


FIGURE 17. JACKSON SUBAREA FACILITIES MAP



There are numerous possibilities for increasing hunting opportunity and use by providing additional access to lands and waters. Many of these possibilities involve indirect approaches where the attitude of the owner controlling access must be favorably directed to providing hunting access. This is, at best, a temporary measure since attitudes may change. Long-term leases or fee-title purchase of access sites or blocks of land by public agencies represent the most lasting, direct approach to creating additional hunting opportunity.

Approximately 85% of Michigan's residents live in the southern third of the State, while 96% of the public lands lie in the northern two-thirds. Lands are constantly being acquired or agreements are being made with private land owners by the Michigan Department of Conservation to provide hunting opportunities for the southern Michigan resident.

In 1937, the United States Congress passed the Federal Aid in Wildlife Restoration Act, more commonly called the Pittman-Robertson Act (The Dingell-Johnson sport fishery restoration program is the counterpart to the "P-R" wildlife program). Under this law, money from an excise tax on sporting arms and ammunition was made available for game restoration projects. For every 75 cents of Federal money, the State contributes 25 cents. Because the primary purpose of the Act was wildlife restoration, Michigan has used these monies to acquire land and restore its capability to produce an abundance of wildlife. In doing so, they have also furnished public shooting grounds where they were most needed.

The State of Michigan Game Areas have been placed in localities that meet the following criteria:

1. The land in the project area is either too poor for general farming or its withdrawal from agriculture would not seriously reduce the economy of the area.
2. Each game area is large enough to be worthwhile and form an economical manageable land unit.
3. The areas have a good potential for game restoration.
4. Land prices are reasonable compared to surrounding lands.
5. The areas are close enough to population centers to assure substantial public use.

By 1942, the State had acquired 30,000 acres in eight game areas. By 1951, ownership was up to 67,000 acres on 31 areas, and by 1960 game areas covered 201,000 acres, scattered throughout the Lower Peninsula.

The Grand River Basin had nearly 87,000 acres in State-owned public hunting and recreation areas at 17 sites in 1965. The goal acreage for these sites totaled 153,000 acres. These 17 sites are located on Figures 13 through 17 and their present and goal acreages are presented

in Table 6. The greatest concentration of State-owned public hunting areas were in the West Central Belt Subarea.

These areas are managed by improving the land through habitat manipulation. Habitat improvement includes, among other practices, tree and shrub plantings suitable for desired wildlife species, planting food patches, making meadow plantings which provide nesting sites, creating brush piles for wildlife shelter, creating small dams for flooding to benefit ducks and furbearers (Montcalm and Barry counties-Figure 14), and careful application of herbicides to control unwanted or unproductive vegetation.

The sportsman and the State of Michigan will face increasing pressures to use these lands for industrial, residential, or agricultural development as populations expand. The importance of State-owned "open-areas" is obvious; they should be expanded now, before land costs continue to spiral.

Hunting use on public lands (1.33 man-days per acre) is significantly greater than private acreage (0.30) due to public access and hunting success being greater on managed areas, which makes them more attractive to the potential hunter. It is also apparent that hunting use of a given unit is directly dependent on the location of the area . . . . . near centers of population, easy access, etc. Surveys were made on 27 upland type game areas through the four-month hunting season of 1955-56, and a similar waterfowl area survey was made in 1956 (18/34-37). Approximately 18 small-game animals per 100 acres were taken on public areas. It was 50 percent greater than the computed kill for private land in southern Michigan, which averaged 12 pieces of game per 100 acres. However, the total game area harvest was 70% rabbits and squirrels and 12% pheasants, where the private harvest was 60% pheasants.

State game areas averaged 183 upland game man-hours for each 100 acres of land and 1,775 waterfowl and scattered upland-game man-hours for each 100 acres of marsh habitat (18/35). Hunting pressure was heaviest on opening day, weekends, and on Thanksgiving Day and the day following. Palmer (19), examining more recent statistics on selected State Game Areas, estimated that marsh habitat received .08 gun-hours per acre per day through the waterfowl season (Oct. 13-Nov. 11). Upland game habitat supported .05 gun-hours per acre per day through the waterfowl season, and .03 from Nov. 12-March 1. The total hunting pressure was 5.6 annual gun-hours per acre. This figure has been converted to 1.33 man-days per acre for use in this report.

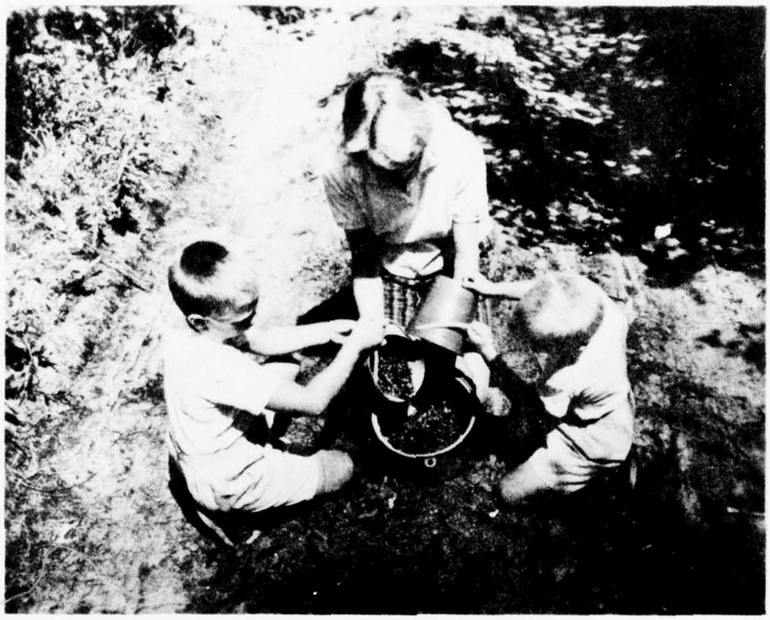
It was further stated that the average one-way distance from the hunter's residence to the area of hunt was 29 miles to State Hunting Areas and 24 miles to private lands.

On State game areas, rabbits and squirrels made up 70 percent of the total harvest.

Palmer (20) also reported on the importance of State Hunting Areas to the non-hunter, who uses the areas for various resource related uses. His study included the Allegan State Forest and Swan Creek Wildlife Experiment Station immediately southwest of the Grand River Basin (both State Game Areas are within Region III, but out of the Basin), and Rose Lake Wildlife Experiment Station within the Basin. He concluded that during the 1961 and 1962 seasons:

1. Non-hunting-season use of these particular State lands is heavy. Approximately 1.6 million man-hours of recreational activity was furnished.
2. During the hunting season, use totaled about 990,000 man-hours. State game areas thus furnished over one

and one-half times more associated recreation use in fall and winter.



State game areas furnish over one and one-half times more associated recreation use in spring and summer than they do hunter use in fall and winter.

3. Non-hunting-season use of State game areas is varied. The more important activities, in order of importance, are fishing, picnicking, berry-picking, swimming, camping, sightseeing, boating, and mushroom hunting.
4. Spring and summer game area users are predominantly local people.
5. Camp grounds, picnic sites, and other types of special-use sites should be developed with discretion on game areas. Such developments tend to induce mass use so prevalent in

parks and recreation areas. The wide spectrum of recreational possibilities now offered by game areas should conceivably be narrowed or their hunting appeal and game value will be reduced by over development of non-hunting facilities.

The Manistee National Forest, partially within Montcalm County (Figure 14), and State Parks in Ottawa County (Figure 13) and Jackson County (Figure 17) also provide additional public hunting opportunities. National forest lands averaged 0.17 hunter days per acre, and State park lands averaged 0.62 hunter days per acre in adjacent states encompassed by the Ohio River Basin (21/13).

Williamston Plan lands provide additional hunting opportunity for Grand River Basin residents. The idea for this plan was originated in 1929, with an experimental area located in Williamston Township in Ingham County. A number of farmers, whose lands adjoin, group their acreage into one large block of land. The combined lands are posted with signs stating, "No Hunting Without Permit". Each farmer is given a limited number of hunting tickets, which he gives out each hunting day until his supply is gone. No additional hunters are allowed in his fields until someone is through hunting and returns his ticket. There is no charge for the ticket, but the farmer has better knowledge and control of who, where, and how many hunters are using his property. These Cooperative Hunting Clubs have had varied success.

In 1936 the Conservation Department's Game Division began sponsoring these cooperative clubs. By 1940, the program reached its peak, with over 120 areas covering a total land area of one-half million acres located in southern Michigan's small game hunting territory. This figure dwindled to 27 areas in 1944, but climbed to 35 areas covering 112,000 acres in southern Michigan in 1965. There were 14 areas with nearly 51,000 acres within the Basin in 1965. These areas are located on Figure 13 through 16, and area acreages are listed on Table 7.

The Federal Cropland Adjustment Program, U.S. Department of Agriculture, has opened additional private acreage. Under the program, coordinated in Michigan by the Conservation Department, about 1,000 landowners have agreed to provide public hunting access to more than 100,000 acres, mostly in the southern half of the State. In return, these landowners receive special fees from the Federal Government over and above payments for diverting their acreage from crop production to conservation land practices. Some lands open to public hunting also offer public access for fishing, trapping, and allied outdoor experiences. This program became operable for the first time during the hunting season of 1966 and 1967.

Another method of satisfying the demand for hunting opportunity involves privately owned acreages which are open to the public on a user-fee

basis. These acreages are intensively managed and stocked, "under-the-gun", with game birds. The number and type of fee hunting areas are related to the quality and quantity of local hunter demand. In many cases, access to private fee hunting areas is considered a status symbol. Therefore, these developments often cater to a clientele which would not normally use other public or private hunting opportunity.

In the Grand River Basin, shooting preserves range from those open to the public on a membership or invitation basis to those which are private closed clubs. Shooting preserves are limited to 640 acres, but must be at least 80 acres in size if upland game birds are hunted or 50 acres if only mallard ducks are flown and shot. There were eight shooting preserves in the Basin in 1965 (Table 8). Basin shooting preserves offered pheasants and/or chukar partridge to the member or guest. None provided waterfowl hunting. Licensing and regulation governing the operation of shooting preserves are the responsibility of the Michigan Department of Conservation. No county may have more than one percent of its gross land area licensed to shooting preserves. No county within the Basin is approaching this one percent restriction.

All fee-shooting areas were located within 30 miles of a metropolitan area, and the majority were in the eastern portion of the Basin northeast of Lansing (Figures 14 through 16).

SECTION IV

FUTURE DEMANDS ON FISH AND WILDLIFE RESOURCES

Traditionally, fish and wildlife resource planning has developed on a three-phased approach; 1) an inventory of physical and biological resources; 2) an estimation of future demands on these resources; and 3) a plan of development to satisfy the demand. The rationale of the approach and methods of providing the needed information have varied from study to study, but these elements are usually present.

In this study, as in the Ohio River Basin Comprehensive Study (21), the "user-day" was chosen as the index of comparative need. The plan simply weighs user-days provided by the existing conditions supplemented by acquisition or construction of proposed fish and wildlife facilities, against the number of user-days required. These plans are based on several premises, a major one being, that if the necessary lands and waters are acquired and made available to the public, the resource manager and researcher will in turn provide the stock of fish and game required to sustain the increased demands for hunting and fishing.

In the development of a model which would accurately project future demands for hunting and fishing, the approach was limited to those factors which were judged "significant determinants" and were quantified in some available reference. This engendered a certain amount of trial and error to verify or reject opinions of the "significance" of given factors. Even with significance verified, it became evident that the integrity of our projective methodology depended to a great extent on the assumption that contemporary relationships between variables would remain constant during the interim covered by the projections. While this assumption will obviously be subject to error, it is common practice to logically extrapolate past patterns or trends to arrive at a forecast of future events.

Our further studies made it obvious that we were incapable of quantifying or even of becoming knowledgeable of all the factors which could influence the demands for fishing and hunting experiences.

A special effort was made to reduce our determinants to lowest common denominators; and every attempt was made to base our methodology on data pertinent to Michigan, if not specifically to the Grand River Basin. In a study area this small, the use of National or even Regional coefficients could seriously bias results.

The methodology used to convert population projections of the Grand Rapids subarea into sport fisherman demands is taken through the appropriate calculation procedures in Supplement 1, this report.

17. PROJECTED POPULATIONS

Present and future demands for hunting and fishing are obviously, in a fundamental sense, a function of size and distribution of the study area's population.

Population projections for the Grand River Basin and its five subareas (Tables 9 and 10) were prepared by Battelle Memorial Institute, Columbus, Ohio, for inclusion in the Basin's Economic Base Study, Appendix O (1/I-134). The delineation of subarea boundaries, as defined in the Economic Base Study, was also used in this report.

Knowledge of the relative urban-rural population relationships was vital for estimating future demands for hunting and fishing. Fishing, and particularly hunting, long have been basic recreation to rural-oriented populations (22/13). For example, all adults (18 years of age and above) who live in Standard Metropolitan Statistical Areas with populations over one million, hunt an average of 0.25 trips per year; but all adults living in rural, farm areas hunt 4.43 trips per year (23/36), a ratio, rural to urban, of about 18 to 1.

There are fundamental sociological problems associated with using the Bureau of Census' definition of an urban population (incorporated places of 2,500 or more) as reflecting normal urban character. For example, a town of 4,500 located in a comparatively uninhabited area has few urban characteristics which would moderate the inhabitant's traditional desire to hunt or fish. Conversely, residents of unincorporated villages of less than 2,500 on the fringe of a large metropolis, will likely be urban oriented. Population densities, expressed as population per square mile, remove these potential misinterpretations and provide a greater degree of comparability between socially homogeneous areas.

Population densities were projected to increase from a mean Basin figure of 162 people per square mile in 1960, to 222 in 1980, 312 in 2000, and ultimately 426 people per square mile throughout the Basin in 2020.

18. PROJECTING FUTURE DEMANDS

Hunter and fishermen demands are a function of participants and annual participation. The result of these two factors is termed gross demand and is expressed in man-days of use.

a. Projecting future number of participants. The number of hunters and fishermen projected to use the wildlife resources of the Grand River Basin is a composite of licensed and unlicensed users, plus an estimate of latent demand, with the result adjusted to account for net ingress-egress patterns of participants across Basin boundaries.

(1) Licensed resident demand. License sales have proven to be the best available index of hunting and fishing demand. Most people who hunt or fish are required to buy licenses, and the act of buying a license expresses a definite desire to hunt or fish. License sale records, on a county basis, are readily available, and various studies have provided indices to the relationship of unlicensed to licensed

The act of buying a hunting or fishing license expressed a definite desire to hunt or fish.

participation. Resident fishing and hunting license sales for 1960 were totaled for each planning subarea and sales per capita for each were determined for use in the projective model.

Total resident licensed fishermen were directly available from records. Trout fishing requires a special fee, however this did not confuse the totals because a fishing license is a prerequisite to obtaining a trout fishing stamp. Determining total, resident licensed-hunters did require interpretation, due to a multiplicity of required licenses and the possibility that an individual hunter might be represented in one category without appearing in another grouping. For example, a resident hunter is permitted to buy a resident small game, deer (gun) license, and/or a deer (bow and arrow) hunting license. He is not required to buy one particular license to secure another.

By comparing the number of individuals holding some type of resident hunting license during 1962 in Michigan (24/13), to the number of Michigan resident small game and deer license sales for 1962 (Michigan Conservation Department summaries), it was determined that 75 percent of total license sales approximated the total number of licensed hunters. Therefore, by taking 75 percent of the total 1960 Basin resident small game, deer (gun), and deer (bow and arrow) licenses, determinations of total Basin resident licensed hunters were obtained.

License sales in most subareas are indicative of related factors. By determining what these factors were, and which ones were represented by quantitatively available data, a projection of future subarea license sales is possible.

As in other similar studies, the population density of the projective subareas in the Grand River Basin was inversely correlated with per capita sale of hunting and fishing licenses. The coefficient of correlation (r) was highly significant at the 99 percent level of probability when resident hunting license sales were related to population per square mile within the subarea where the potential hunter resided. The r value relating resident fishing license sales and population densities was significant at the 95 percent level of probability. These were extremely high probability levels, and were therefore used in our projection model. Analysis of both 1950 and 1960 resident license sales and populations was made to better affirm the reliability of this relationship. Correlations were strong for each year, indicating that projections of this historical trend are statistically reliable.

Palmer's estimate of the relatively short average distances a hunter traveled to hunt (19), indicated there might be a relationship between Grand River Basin subarea resident hunting license sales and hunting opportunity immediately available within the potential license buyer's

subarea. This relationship has been shown to exist within the Ohio River Basin states (21/27-29). Upon testing, it was found that the correlation coefficient (r), between resident hunting licenses per capita and acres of potential hunting land per capita, was highly significant at the 99 percent probability level. A similar relationship between the subarea sale of fishing licenses per capita and acres

The inter-relationship between resident license sales, areas of locally available opportunity, and population densities appeared to provide the best available method for determining future license sales.

of fishing habitat per capita was also highly significant. These relationships also included data from 1950 and 1960 to insure that this relationship was not atypical of historical conditions.

Other factors which might influence license sales were considered but were either not quantitatively defined or if data were available their

inter-dependence was not significantly correlated and would therefore provide spurious projection results. Mueller and Gurin (22/10) stated that fishing and hunting participation showed no clear increase with rising income. This was particularly interesting, because these two activities require more expense than do hiking, picnicking, and nature and bird walks, which entail minimal expense, but increase in participation frequency with income. Education (22/11) generally showed a strong relationship with general outdoor activity; those having more years of schooling being more likely participants. However, men with a college education participated less than men who were high school graduates, indicating that an upper threshold was established at approximately 12 years of schooling. With changing education patterns expected during the projection years, and education being reflected in part by age and income differences, this study could not justifiably use this factor as an accurate indicator of future hunting and fishing demands.

Participation by the potential outdoor recreationist (all outdoor activities) appeared to be greater for those in higher status occupations, but this was due in a large part to three related factors - income, education, and length of paid vacation (22/11). The difficulties of establishing these relationships with the known occupations of deer hunters in Michigan (25/5) suggested that this factor could be disregarded as a firm determinant of future participation. Paid vacation however was considered as a determinant of latent demand which is discussed later in this section.

After due consideration of factors shown to be related to participation in various outdoor recreational pursuits, the inter-relationship between resident license sales, areas of locally available opportunity, and population densities appeared to provide the best available method for determining future license sales as a function of projected population. An estimate of the number of future resident licensed fishermen and hunters, by subarea, was determined by applying per capita subarea resident license sales factors to subarea population densities. Multiple regression equations relating 1960 subarea opportunity and subarea population densities to license sales were developed. Each computed 1960 subarea license sales per capita factor was adjusted as it deviated from the known 1960 per capita license sale, to partially account for various unknown determinants specific to each particular subarea. We assumed that these random elements will remain constant and that their effect on "Y" will remain nearly the same over the projection years. Adjustment factors were not large, but were thought to provide increased accuracy when applied to 1980, 2000, and 2020 determinations.

The regression formulas are:

Fishing

$$Y = .139 - .00006\ X_1 + .33318\ X_2$$

Where

Y = Resident fishing licenses as percent of population.

X_1 = Population per square mile.

X_2 = Acres of fishing habitat per capita.

Hunting

$$Y = .098 + .000002\ X_1 + .01013\ X_2$$

Where

Y = Resident hunting licenses as percent of population.

X_1 = Population per square mile.

X_2 = Acres of hunting habitat per capita.

The strength of the "X_1" variable, population per square mile, is partially masked in each equation by the interaction between the two "X" variables. The numerical size of the constants associated with the "X_1" and "X_2" variables would indicate a severe masking effect. However, the reader should consider that the "X_1" variable is a large number (generally well above 100) and the "X_2" variable is a much smaller number which dampens the effects of the larger "X_2" constant. Thus, the "X_2" variable (acres of habitat per capita) does become the more powerful determinant of "Y" (resident licenses as percent of population), but not to the extent that the casual reader might interpret from looking at the two equations.

(2) Licensed non-resident demand. Non-resident demand for Basin resources was much more prevalent for fishing (Figure 8) than for deer hunting (Figure 10) or small game hunting (Figure 12). Consideration of non-resident demand is included in the ingress portion of the net ingress-egress determination factors, and is an important factor in partially offsetting egress from the Basin.

(3) Unlicensed demand. Most sportsmen who hunt or fish are required to buy licenses and to pay specific fees to the State or Federal governments. Sportsmen who are exempted in some states from

these license requirements include: (1) those over or under a specific age; (2) the disabled; (3) active servicemen; (4) property owners; (5) wives of license holders; and (6) aborigines and indigents. In the last several years there has been a National trend to tighten up license requirements. This is clearly indicated in the age requirement category. In 1955, persons under 16 years old could fish without a license in over half the states. In 1960, persons under 16 years of age could fish without a license in only 9 states (26/66-67). Most states have now canceled the privileges of free fishing formerly given to veterans and active servicemen. However, with the escalation of war overseas, some states are again permitting free privileges to active resident servicemen (27/71).

There are several individual groups excluded from having to buy resident fishing licenses in Michigan and the Grand River Basin. No license is required for wives of resident fishing license holders, of those anglers

Wives of resident fishing license holders are not required to buy a license; they constitute an estimated 18 percent of total Basin anglers.

interviewed on all types of fishing habitat in the Basin from 1958 through 1962, females made up 18 percent of the total. Assuming that most of the females were unlicensed, either because they were wives of licensed anglers or under the required age, the number of resident licensed male anglers in each subarea were adjusted from 13 to 23 percent to provide an estimate of unlicensed female anglers for each subarea.

The ratios of male to female anglers varied from approximately 5:1 on warmwater habitat to 20:1 on trout waters. An increase in warmwater habitat would probably generate an increase in unlicensed female anglers.

To further expand the Basin's fisherman base, the total of the individual subarea's resident female and male anglers were increased by 25.8 percent to account for unlicensed anglers under 17 years of age.

This figure is the percentage of anglers from 12 to 17 years of age to total anglers that fished in freshwater throughout the United States in 1960 (26/53).

An estimate of unlicensed Grand River Basin anglers using the Great Lakes was not available, and therefore could not be included in the unlicensed demand expansion analysis.

National figures denoting the percentage of licensed anglers to total anglers for 1955, 1960, and 1965 were 61%, 66%, and 59%, respectively. A similar estimate for the Grand River Basin in 1960 would amount to 68.3 percent. This would be a minimum estimate of unlicensed anglers, because information on the numbers of non-licensed Great Lakes and illegal anglers was not available. One would expect the percentage of licensed anglers in Michigan to fall below the National mean because of its liberal attitude toward angler licensing.

Data were not readily available on number of unlicensed hunters from the Grand River Basin. The primary category of unlicensed resident hunters in the Grand River Basin, is those who hunt on farmland where they either work or live.

Ryel (25) attempted to estimate the number of 1964 deer hunters that hunted small game on their own farm without a license, thus lawfully taking advantage of this license exemption. Using data from those residents who listed farming as their primary occupation, he estimated that 42 percent of the "farmers" took advantage of the exemption. In discussing this percentage, he concluded that the potential for unlicensed hunters may be large; but since this study only concerned a sample of those small game hunters who hunted deer, a non-licensed figure encompassing all small game hunters was not developed.

National statistics (26) (27) of the percentage of licensed hunters to total hunters for 1955, 1960, and 1965 were 84%, 81%, and 84%, respectively.

The 1965 figure was used for projections of unlicensed hunters from the Grand River Basin in this report, and licensed hunters were therefore expanded by 20 percent to account for unlicensed hunter demand.

(4) Latent demand. To this point, all efforts have been directed at measuring and projecting fulfilled demand. Unfulfilled or latent demand is difficult to estimate and to project. A National survey probing this problem was undertaken in 1959-60 and published in 1962 (22/6-9 and 30-38).

In this study when asked, "What was it, mainly, that prevented you from participating (in a given outdoor activity) last year?", the respondents (18 years and older) answered: (22/Table 7)

1.	Lack of leisure time	52%
2.	Cost, no car, no equipment	26%
3.	Ill health, old age, family ties	22%
4.	Miscellaneous (fear, lack of ability, etc.)	13%
5.	Lack of available facilities	9% *

Item 2 was of questionable value in a latent demand factor, because of the limited relationship between the effect of cost or no equipment on whether a person hunted or fished (22/10, 23/Tables 1.16 and 2.16). Items 3 and 4 should remain comparatively constant throughout the projection years. People will continue to have family ties, health problems, and miscellaneous reasons depriving them of leisure activities. Items 2, 3, and 4 were therefore removed from consideration in developing a latent demand factor. This decision was supported by data presented in reports dealing with the National Recreation Survey (22/7)(23/20-42). Items 1 and 5 were considered to be the more influential items in determining future latent hunting and fishing demands.

The magnitude of expected increased leisure time (Item 1) was projected by the Department of Labor in 1961 (28/67 and 72). Their 1960, 1976, and 2000 estimates for average weekly hours worked were 38.5, 35.4, and 30.7, respectively; average annual vacation weeks were 2.0, 2.8, and 3.9, respectively; and average annual holidays were 6.3, 8.5, and 10.1, respectively. However, it can be expected that many people, especially urban dwellers who are given additional leisure time, will increase participation in their present favorite recreational activities and not branch out into fishing or hunting activities.

Lack of available facilities (Item 5) can be satisfied by providing additional hunting and fishing opportunities. Since this opportunity factor is included in the projection formula, as acres of habitat per capita, it also has been eliminated from consideration in the development of a latent demand factor.

* Multiple response from a single contact prevents total from summing to 100 percent.

Nationally, it has been estimated that 8% of the adult population (18 years and older) would like to begin fishing and 13% would like to fish more (22/Table 6). The hunting estimates were that 5% would like to begin hunting, and an additional 5% would like to do more hunting. No reference was made to the number of times the respondent would like to increase his hunting or fishing activity. Therefore, the percentile expressions in the following paragraph only apply to the number of nonparticipants and not to the marginal participant.

For reasons given above, development of a latent demand factor considered only lack of time as a reconcilable deterrent. *

The scope of coverage was increased to adapt the latent demand factor to the total population, not just those over 17 as considered in Mueller and Gurin's work. By considering the effect of lack of time upon the total population desiring to begin fishing or hunting, an estimated 2.60% of the Basin's population have unfulfilled demands for a fishing experience and 1.63% for a hunting experience.

(5) <u>Participants from the Basin</u>. Total anglers from the Basin were estimated at 202,800 in 1960. This total is projected to increase 50% by 1980, 100% by 2000, and 151% by 2020 (Table 9). Corresponding increases in hunters, from a 1960 base of 174,300 are expected to amount to 40% by 1980, 86% by 2000, and 143% by 2020 (Table 10).

It was noted that hunters and fishermen from the Basin are projected to increase at approximately the same rate as total Basin populations up to the year 2000. Population increases, when compared with 1960 Basin populations, are increasing 38% by 1980, 93% by 2000, and 163% by 2020. The moderating rate of increase in hunters and fishermen residing in the Basin as compared to the sharp increase in total population after 2000 is attributable to increasing urbanization and decreasing opportunity per capita, particularly for hunting experiences. Both conditions tend to reduce desires to hunt or fish.

(6) <u>Participants using the Basin</u>. Basin hunter-and-fisherman ingress and egress travel patterns are discussed previously in this report. The net sportsmen gains or losses, by subarea, were used to obtain estimates of both present and future participants using the Basin's resources. These participants were not necessarily from within the Basin or the State; nor does the estimate include those Basin residents who neither hunted or fished in the Basin.

The percentage of participants using the Basin subareas, of those participants residing in the Basin subareas were: **

*Lack of time due to work or family responsibilities.

**100% would indicate equal ingress and egress for a particular subarea, 150% would indicate that for every two participants from the subarea there were three using the subarea.

	Fishing	Hunting
Grand Rapids	39.7%	68.4%
West Central Belt	103.9%	138.0%
Lansing	57.7%	81.4%
Northeast Fringe	68.8%	81.4%
Jackson	167.3%	77.3%

These factors were applied to projected participants from Basin subareas, for each target year, to derive participants using each subarea. It would be gross speculation to attempt an estimate of changing hunter and fisherman travel patterns, with data presently available. It was therefor assumed that the growth or reduction of outdoor opportunities, transportation facilities, and other socio-economic factors affecting hunter and fisherman travel patterns would continue at equivalent ratios now existing between the Grand River Basin and surrounding areas.

Estimates of total anglers using Basin resources were 146,900 in 1960. This estimate is projected to increase to 218,700 by 1980; 291,300 by 2000; and 369,200 (Table 9). Similar estimates for hunters using Basin resources were 146,700 in 1960; 203,300 by 1980; 265,100 by 2000; and 342,800 by 2020 (Table 10). These estimates assume that a portion of the programs, as presented in the plans section of this report, will become a reality prior to the given target dates.

b. Projecting future annual participation. Average annual hunting and fishing participation was calculated and projected for each subarea. The average 1960 subarea participation was estimated by multiplying total acreage of various types of subarea habitat times the average use per acre, as determined by various Michigan studies, then dividing by the number of 1960 participants using the subarea's resources.

The average annual estimated subarea participation values were:

	Man Days Fishing	Hunting
Grand Rapids	12.0	6.3
West Central Belt	16.3	12.0
Lansing	4.7	9.7
Northeast Fringe	7.7	14.8
Jackson	7.6	11.9

The weighted average Basin participation values were 10.3 annual days use per angler and 10.0 annual days use per hunter. These participation figures approximated the National medians of 9.0 days use per angler and 8.2 days use per hunter rather than the Nation at means of 18.4 and

13.2 days respectively. In 1960, the relatively urban Ohio River Basin had average annual participations of 10.6 hunter-days use and 8.3 angler-days use throughout the Basin (21/11).

Grand River Basin angler participation in 1960, by subarea, was also strongly correlated with opportunity, represented by acres of fishable* ponded water and streams. The correlation coefficient (r) was highly significant at the 99 percent probability level for this relationship. Although a predictable relationship between the number of licensed anglers (participants) and the subarea's population density did exist in the Grand River Basin, a significant relationship between the number of times one fishes (participation) and the subarea's population density did not exist. The Ohio River Basin Study's findings were the same (21/31).

The most accurate denominator of future angler participation in the Grand River Basin was represented by a linear regression relating participation to an index of available opportunity, and not to human population density characteristics. The 1960 data is best represented by the equation:

$$Y = 1.73 + 23.93\,X$$

Where

Y = Annual angler participation.
X = Acres of fishing habitat per angler using the subarea.

Adjustment factors for this equation were based on the differences, if any, between the calculated and actual 1960 angler participation. These adjustment factors were applied to the projected subarea participation to partially account for various unknown determinants specific to each particular subarea.

The fishing opportunity available in 1960, plus an estimate of developments planned for construction by 1980, were summed and the result applied to the regression to compute 1980 angler participation values.

The factors, which influenced the individual to buy a hunting license, also induced the hunter to spend additional days afield. Hunter participation depends strongly upon the subarea's population density (r-significant at 95 percent probability level), and hunting opportunity per subarea user (r-significant at 99 percent probability level). A multiple regression based on 1960 subarea data, relating these factors, is represented by the equation:

* Capable of sustaining a sport fishery regardless of accessibility.

$$Y = -0.11 + 0.00002\,X_1 + 0.36784\,X_2$$

Where

Y = Annual hunter participation.

X_1 = Population per square mile.

X_2 = Acres of hunting habitat per hunter using the subarea.

Hunter participation adjustment factors and projections were developed as they were for angler participation figures.

19. PROJECTING FUTURE NET DEMANDS

A comparison of projected supplies and gross demands permits an evaluation of future net hunting and sport fishing demands.

a. Gross demands. To arrive at projected instantaneous gross demand figures for the target years 1980, 2000, and 2020, the projected 1980 hunter and sport fisherman participation rates for each subarea were assessed against each subarea's projected 1980, 2000, and 2020 participants. Gross subarea and Basin demands, expressed as angler and hunter days, are shown on Tables 9 and 10, respectively.

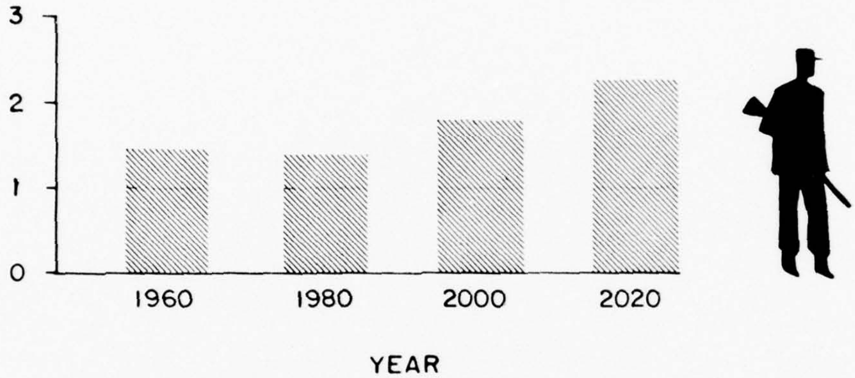
Gross demand for fishing generated in the Basin is expected to increase from 1,517,000 angler days in 1960 to 2,000,300 in 1980 (32%); 2,647,400 in 2000 (75%); and by 2020, demand is estimated to be 3,341,400 angler days or a 120% increase when compared to 1960 angler demand (Figure 18).

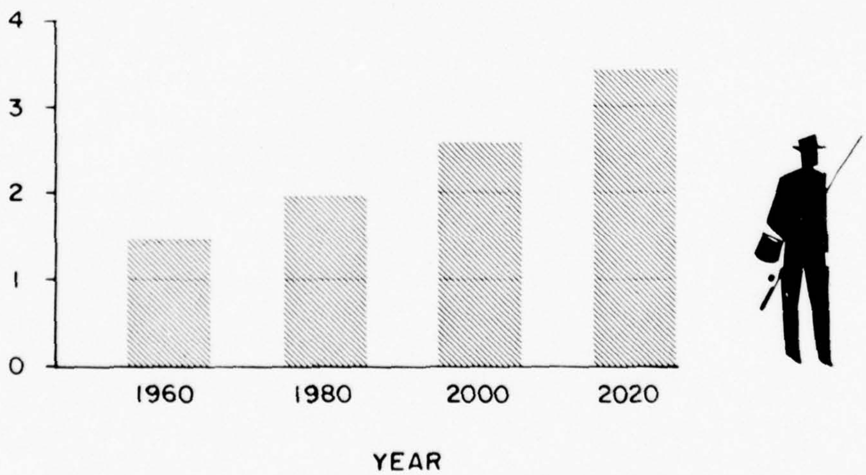
Gross hunting demands were estimated to be 1,459,100 hunter-days use within the Basin in 1960. Demand is expected to decrease slightly to 1,400,900 hunter days by 1980 (-4%); then increase to 1,790,300 by 2000 (23%); and ultimately to 2,269,700 hunter-days use by 2020, an increase of 56% when compared with 1960 gross hunter demand (Figure 18). The decreased overall Basin demand predicted from 1960 to 1980 is a result of a projected decrease in number of days of participation per hunter, even though the actual number of hunting participants is expected to increase in the interim 1960 to 1980. Indications are that decreasing participation may level off by 1980. This, in conjunction with continued increasing numbers of hunters will result in increased gross demands by the year 2000 and 2020. Strategically located hunting opportunity developments, in place by 1980, should generate demand by increasing participation rates, while also satisfying existing unfulfilled hunter needs.

b. Supply. After determining gross demand within the Basin, it was necessary to estimate future changes in opportunity (supply),

FIGURE 18. GRAND RIVER BASIN GROSS HUNTING AND SPORT FISHING DEMAND FOR 1960, 1980, 2000, AND 2020

MILLIONS OF USER DAYS





represented by acres and type of hunting and fishing habitat. The 1960 indices of pressure on given units of habitat (Tables 1 and 4) can be considered near their capabilities, at least within the framework of known or foreseeable determinants. Indications are that pressure on a given area of habitat remains relatively stable, over a period of years, if the resources sustained on the habitat remain comparably stable. Therefore, that portion of the habitat base present in near future years should support hunting and fishing at a rate consistent with present use.

The angler is normally provided with ever increasing acreages of ponded water to supply fishing needs through reservoir construction programs. Impoundments, however, are usually gained at the expense of stream fishing habitat. To compensate for losses of stream environment it will be necessary to continually attempt to improve residual stream fisheries through better fishing management methods or through more effective pollution abatement programs, while simultaneously extending access provision programs. The initial success of the salmon introduction program

The initial success of the salmon introduction program symbolizes a bright future for many Michigan rivers and streams, including those within the Grand River system.

symbolizes a bright future for many Michigan rivers and streams, including those within the Grand River system, and represents a bold new effort in increasing the fisheries base of the State.

The hunter seldom realizes an increasing habitat base. More often, huntable habitat is consumed by urban sprawl, highways, changing attitudes of landowners towards the hunter, and other habitat-depriving measures of a burgeoning population. Information on projected land use changes, provided by the Economic Research Service, United States Department of Agriculture, East Lansing, Michigan, was taken into consideration in all hunting projections; especially as they indicated reductions or shifts in huntable land bases.

Each resource oriented agency whose program could affect existing or create future Basin fish and wildlife habitat was contacted and requested to project or give estimates of their construction or management plans to the year 1980. Details of these programs are discussed in the following section to this report.

c. Net demands. Near future (1980) net demands for hunting and sport fishing were determined by subtracting existing (1960) use from the projected 1980 gross demand. Consideration was also given to acres of hunting opportunity lost during the interim 1960-1980.

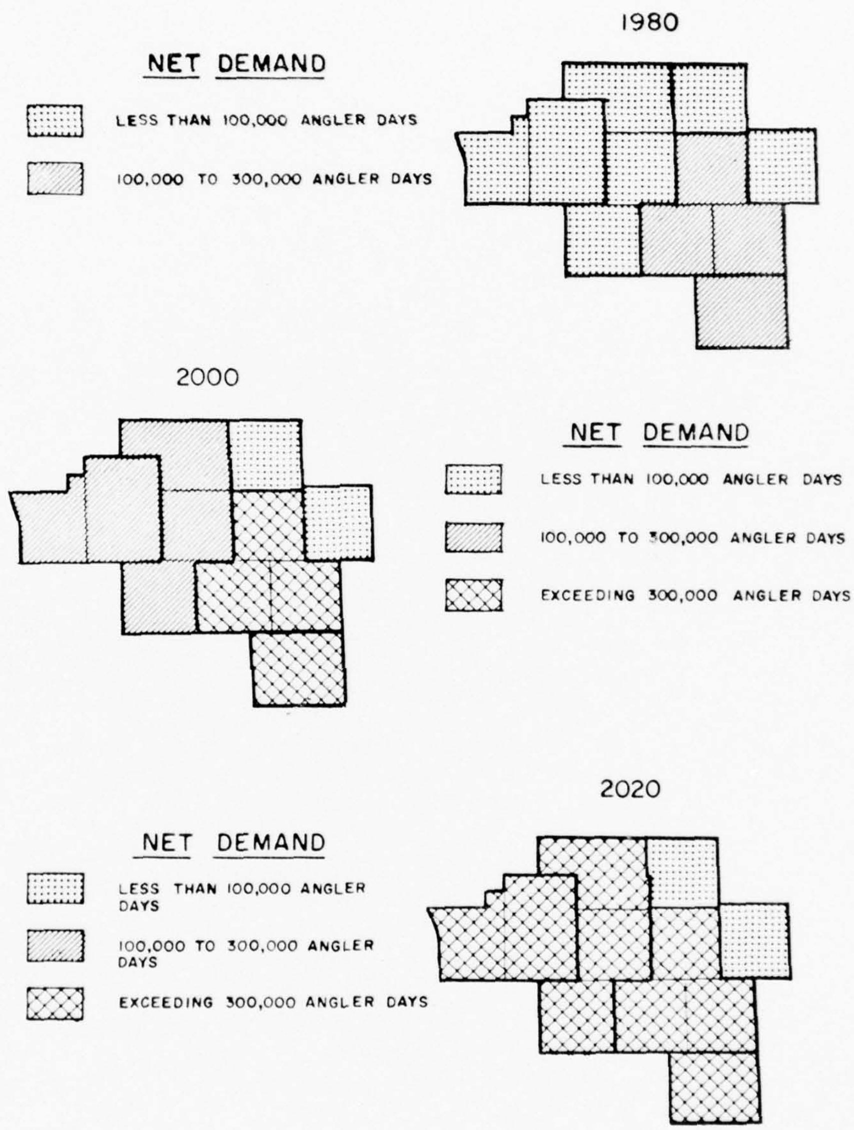
Hunting and sport fishing net demands for 2000 and 2020 were determined using the same method as used for the near-future (1980). Therefore, 2000 and 2020 net demands were a function of the gross demand changes in the interim years (1980-2000 and 2000-2020), the carryover net demands from the previous target year (if any), and in considering hunting needs, the effects of land-use changes on opportunity and use.

The reservoir construction and other fishery development programs completed prior to 1965 and contemplated for the period 1965-1980 will affect angler interest and demand, as will the population increase expected prior to 1980. It is estimated that the 1980 net Basin sport fisheries demand will require an additional 483,300 angler-days of opportunity over that available in 1960 (Table 9). Net demands are expected to increase 1,130,400 angler days by 2000 and 1,824,500 by 2020, over those provided in 1960. Angler needs will not be evenly spaced over the Basin (Figure 19).

Projected changes in land use and availability indicate that 151,000 Basin acres will be lost from the existing hunting base by 1980, an additional 224,000 acres will be lost by 2000, and 282,000 acres will be unfavorably altered as far as hunting is concerned from 2000 to 2020.

Although net demands for additional hunting opportunities are not projected for 1980, net demands will soon appear in the interim 1980 to

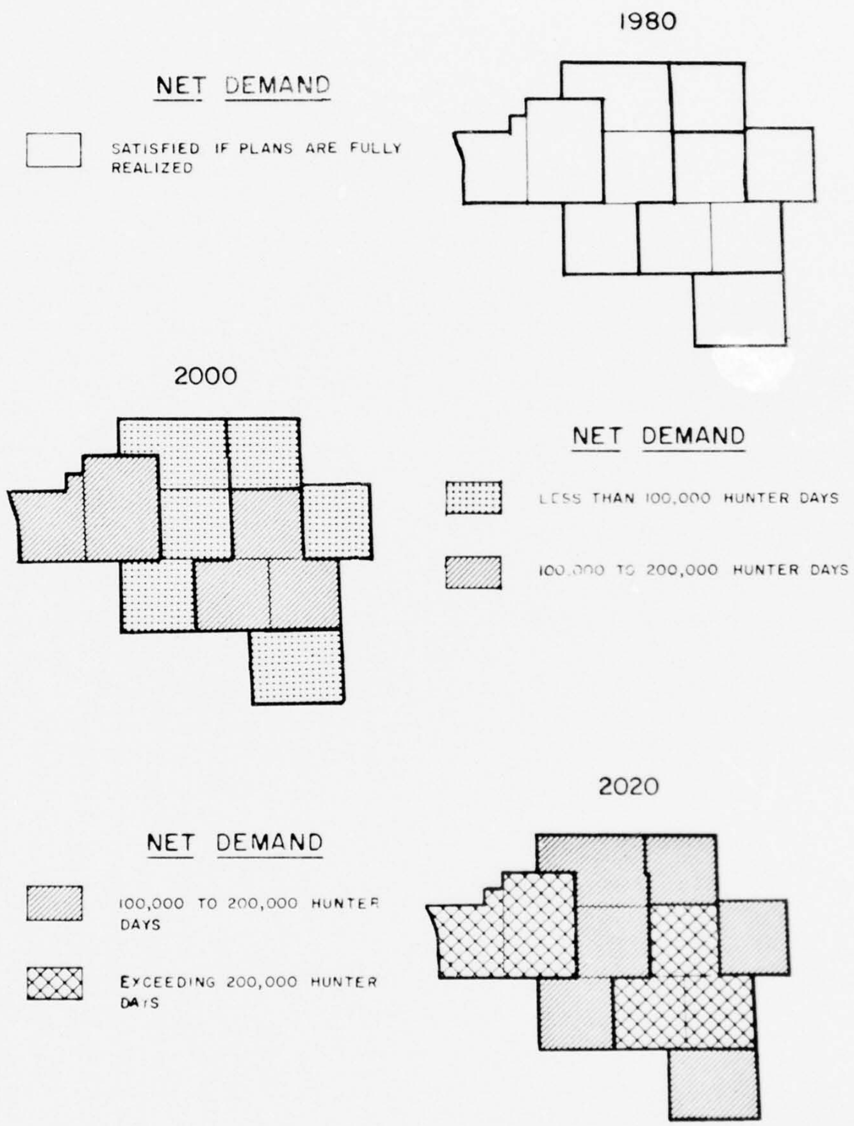
FIGURE 19. GRAND RIVER BASIN SPORT FISHERY NET DEMANDS BY 1980, 2000, AND 2020



2000. By 2000, net hunter demands are expected to be 444,000 user days, then increase to 1,007,800 net hunter days demand by 2020 (Table 10). Figure 20 represents projected net hunter day demands by subarea. Net hunting demands would be considerably greater if all the demand which originates within the Basin, were expended on in-Basin facilities.

Plans presented in the following section to this report will provide guidance in meeting these future net fishing and hunting demands. The number of days-use provided by a particular project completed prior to 1980, would of course also satisfy that amount of demand projected to be present in 2000 and 2020. Where large net demands are not projected for a particular subarea by 1980, lands for future development could be acquired and held in escrow against post-1980 demands. This method would also hedge against escalation of land prices in future years.

FIGURE 20. GRAND RIVER BASIN HUNTING NET DEMANDS BY 1980, 2000, AND 2020



SECTION V

PLANS FOR MEETING NEAR-FUTURE (1980) FISH AND WILDLIFE NET DEMANDS

A principal objective of this study was to develop a single-purpose work plan for the preservation, development, and use of fish and wildlife resources, so that future demands for hunting and fishing may be met. This section is devoted to developing that theme.

20. OVERALL BASIN PLAN

a. Magnitude of future net demands. Resource developments obviously must be located near, or preferably in, the subareas where greatest net demands are expected (Figures 19 and 20). The magnitude of projected Grand River Basin needs, as expressed in user-days in Tables 9 and 10, may be considered minimal under certain analysis. Net demands could have been developed, with reasonably logical models, which would provide a great variation in demand estimates. The method we chose and which has been described in detail in Section IV, resulted in the most conservative estimates of demand of those under consideration.

This approach assumed a stable fisheries base and a decreasing hunting base related to an increasing demand for these experiences; with the results adjusted for expected Basin pressures, rather than planning for local demands which quite likely will be exerted and met outside the Basin. Fish and wildlife developments within the highly populated Grand River Basin can be expected to increase, but not to the degree where total in-Basin demands could be fully satisfied without having to cross Basin boundaries. This report hopefully will provide guidance, encourage and stimulate additional development, and define goals; but one can not assume that utopian conditions will be provided for the hunter, fisherman, or outdoor recreationist in the foreseeable future in the Grand River Basin.

b. Selection of proposed developments. Each agency whose program could affect existing or could create future Basin fish and wildlife habitat was contacted and requested to give estimates of their projected construction or management plans to the year 1980. The Michigan Department of Conservation and Michigan State University provided information or analysis on recreation plans through 1980 (29) (30) (31). Potential reservoir sites were identified by the Michigan Water Resources Commission (32) (33), Detroit U.S. Army Corps of Engineers District (34), Federal Power Commission (35), U.S. Soil Conservation Service (36), and the Tri-County (Lansing Subarea) Regional Planning Commission (37).

A sophisticated screening process was developed to select from these proposed sites and associated lands, those best suited for meeting future

fish and wildlife demands using the following parameters:

(1) Biological considerations. Reservoir sites were considered from both a positive and a negative biological viewpoint. Habitat existing in the proposed reservoir basin was assessed against what the site might offer if developed.

Factors which excluded or radically devaluated the potential sites included: inundation of streams having good trout, smallmouth bass, or walleye fisheries; potential inundation of unique natural areas, State game areas, recreational areas, or parks; and streams having great potential for future anadromous fishery "runs". Discussions with the Michigan Department of Conservation were instrumental in judging the comparative existing and potential qualities of potential sites.

Other factors which received consideration in evaluating and screening structure potential were the existing and expected water quality of the source stream, as well as size, depth and expected use of the potential reservoir's waters and associated lands. Subareas having greatest projected net demands and those having reservoir sites with the best fish and wildlife potential were not always one and the same. Because of this, consideration had to be given to developing sites in a given sub-area, which would satisfy demands generated in an adjacent sub-area.

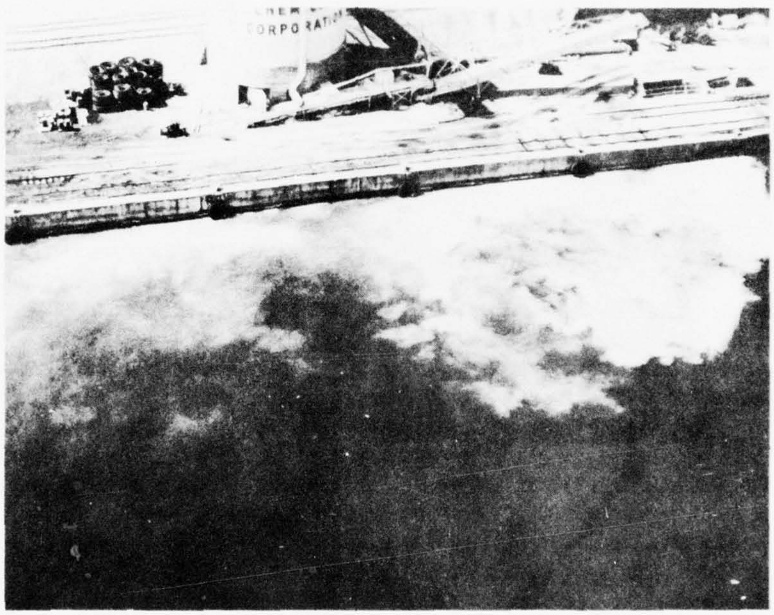
(2) Sociological considerations. There are numerous sociological considerations inherent in our methodology for projecting future hunting and fishing demands. The initial factor for grading potential sites was the projected magnitude and source of need. Within this framework, access to potential sites from areas of demand and the spatial distribution of existing developments were important considerations. Conflicting uses by other sources of demand also received consideration. Potential sites in areas devoid of water habitat were accorded high priority; while sites lying near or beyond developed areas, remote from projected demands, received less attention.

(3) Economic considerations. A number of potential sites have little probability of being developed because of restraining economic considerations. Factors which would usually push development costs beyond favorable B/C ratios include: 1) relocations (residential and industrial developments, sewage treatment plants, railroads, major highways, etc.); 2) topography of site (length or height of dam, ratio of acre feet to surface acreage of multi-purpose reservoir site, flow reliability of tributary streams, ability of dam site or basin to hold water); and, 3) other physical factors which would result in higher costs than benefits for site development.

c. Generalized Solutions for Basin Problems. There are two principal approaches to providing the opportunity needed throughout

the Grand River Basin: one involves increasing utilization on existing resources; and the other, developing new sources of hunting and fishing opportunity.

(1) Increased utilization of existing resources. A great deal of water habitat is degraded through the effects of industrial, municipal, and agricultural pollution. It is imperative that rehabilitative measures be taken on certain of these waters before they become



A great deal of water habitat is degraded through various sources of industrial, municipal, and agricultural pollution.

completely unacceptable to fish life. This problem will be compounded by increasingly insufficient treatment facilities or practices and ever increasing costs for providing adequate treatment. New and improved legislation embodying stronger penalties for violation of pollution laws is needed. Water quality criteria must be proposed that will meet the

requirements of a diversified aquatic community encompassing all life history stages. In setting standards for aquatic life, the Michigan Water Resources Commission has stated (38/18) that it is important that recommendations consider: "the most sensitive species, the intolerant developmental stages, the synergistic effects of combined stresses, the long-term effects of sustained low-level toxicity, and many other factors." If specific waters are classified far below their capabilities for supporting aquatic life, many existing and potential sources of fishing opportunity will be lost or severely impaired.

Fisheries and certain wildlife populations are dependent upon the quality of their aquatic environment. The Michigan Department of Conservation feels that (39/5), "Recent improvement in pollution control laws, techniques, and enforcement tend in the directions of better water quality and, consequently, better wetland wildlife habitat. In spite of the advances, a major effort accompanied by large sums of money will be necessary before this problem is solved. Increased urbanization, expanded and more wide-spread industry, and more general use of toxic agricultural chemicals tend to complicate this problem."

Programs are needed to prevent or remedy unwarranted degradation of existing fish and game resources through dredging, filling, and other land development practives. According to the Department of Conservation (39/3), "Land development on or near water has expanded tremendously with little or no statewide controls which has resulted in serious reduction of formerly quality fishing waters." Wetlands wildlife habitat, once abundant throughout the Basin, has decreased continuously during the past century. The Department further states that (39/4), "The major agricultural drainage occurred in Michigan prior to 1930. Tremendous acreages of wetland wildlife habitat were destroyed as drainage projects, many poorly conceived and unwise, converted swamps, marshes, and in some cases lakes, to crop fields. From 1934 to 1940 over eight million additional acres were drained by Federal relief and other programs, primarily under the guise of malaria control. By 1957, only three million acres of wetlands remained. Although later figures are not readily available, it seems obvious that this acreage continues to shrink in spite of individual and agency efforts to prevent further destruction, restore previously drained habitat, and create new habitat." Where wetlands were previously drained under the pretense of malaria control, the current justification is often termed flood control or watershed management. As in previous years, drainage is often necessary, but far too often programs are not warranted and flood control could best be served by holding waters on the land through better land treatment practices and small reservoirs. It is regrettable that existing philosophies and legislation still permit unwarranted habitat loss through drainage or stream channel modification, despite the sorry history of these operations on a national scale. However, there is evidence of increased interest in programs and legislation

As in previous years, drainage is often necessary, but far too often programs are not warranted and flood control could best be served by holding waters on the land through better land treatment practices and small reservoirs.

which will protect the remnants of wetland habitat from destruction or degradation.

Developments designed primarily for other purposes can often provide secondary or indirect benefits by creating wetlands habitat. For example, road or highway construction, shallow sediment pools in Soil Conservation Service Small Watershed projects, and farm pond construction all can provide habitat of value to waterfowl and other aquatic birds and mammals.

Providing access to existing opportunity is a major consideration in a recreationally oriented state. The Michigan Department of Conservation states (29/22): "Michigan has the largest number of registered boats in the Nation---399,000 as of December 31, 1965, plus an estimated

50,000 non-registered craft. Studies of boating trends indicate the total number can reach 800,000 by 1980. This demand cannot be met without chaos along the waterfront and troublesome problems for boaters and boat businesses unless a vigorous public program is pursued." According to Department surveys, there were 6,300 acres of water throughout the Basin in 1966 which needed access developments. This acreage will certainly increase in relation to the demands of future fishermen. Therefore, the Michigan Department of Conservation is actively undertaking an access acquisition and rehabilitation program which is designed to keep pace with existing and future demands for angler access.

Fishery management programs in future years should provide continuing better use of existing resources and direct attention to areas of effort offering greater return to the sportsman. Research on trout stocking sizes, stocking rates, and angler catch has shown that by stocking greater numbers of sub-legal trout rather than a few large trout, the angler can expect to catch greater numbers of legal-sized trout. This method of "put, grow, and take" is also more economical. Warmwater fishery programs are also receiving additional consideration. Northern pike spawning marshes will be developed. Fishing laws are being liberalized wherever biological data indicate laws are too restrictive. The chemical eradication of problem fish populations, with a subsequent restocking with desirable fish, has been an expanding program. Partial treatments have been used for thinning over-abundant panfish populations to encourage growth and thereby produce more catchable fish. Stunted pan-fish populations are a major problem in Grand River Basin lakes.

The future course of the commercial fishery in the Basin is likely to depend upon the Lake Michigan fishery. In this regard, the Grand River system has been identified as a contributor of sea lampreys to the Lake. Bureau of Commercial Fisheries biologists have carried out chemical control work on several of the lower tributaries of the Grand as part of the overall lamprey control program on the Great Lakes. If no other factors are limiting, present lamprey control work will eventually return Lake Michigan commercial fishery values to levels comparable to those existing before lamprey parasitism. Also, the large populations of alewives currently in the Lake are expected to provide food supplies for increasing populations of lake trout and other important Lake species.

The overall game management program also is providing and should continue to provide for increased use of existing wildlife resources. The soundness of an antlerless deer season in southern Michigan is now accepted. The program has curbed certain deer management problems while at the same time provided needed additional opportunity for the hunter. The mourning dove represents another wildlife species that could provide

additional opportunity without additional cost or hunting acreage, merely by adding it to the game bird list.

Turkeys thriving in Allegan County, which lies partially within the Grand River Basin, suggest that additional introductions might be successful elsewhere in the Basin. Habitat similar to that in Allegan County also exists in Montcalm, Kent, and Barry Counties, with lesser acreages in other Basin Counties.

Continued efforts should be made to repeal bounty laws in Michigan. This antiquated system has no biological basis and is an unnecessary budget drain. Total cost of bounties in 1963 was $242,135, only $160 short of the record payment in 1961.

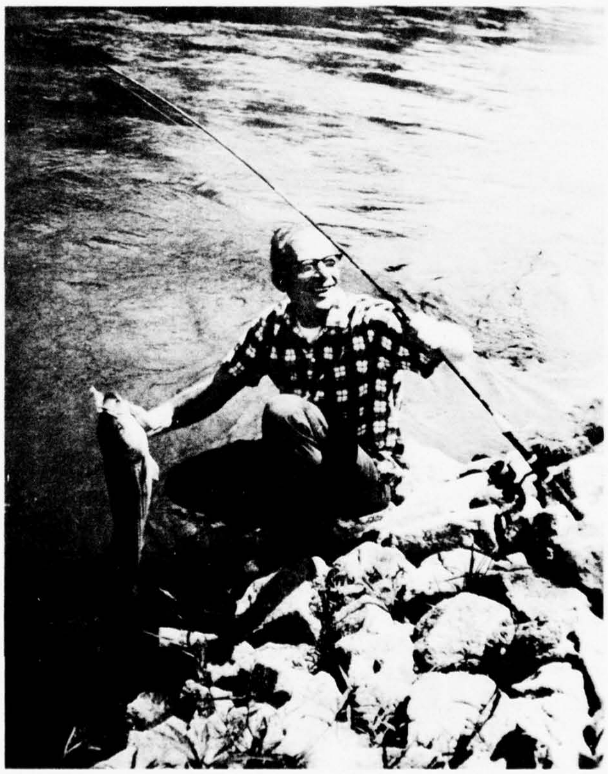
Habitat development has been accelerated on public game and recreation areas. Upland game populations have responded favorably to this type of management, which includes the creation of brushpile shelters, development of additional "edge", increased herbaceous plantings, and more tree and shrub plantings. The Williamston Plan Program and Federal Cropland Adjustment Program should have continued success in providing opportunity to the Basin hunter, at little cost to the State.

Certain Basin areas do not allow hunting on Sunday. If Sunday hunting were allowed throughout the Basin, the worker's opportunity to go afield would be greatly enhanced. Huntable lands and species generally can support greater usage, and hunter participation would increase, with no additional State expense.

Applied research and development are vital to any progressive plan for meeting future fish and wildlife needs. Fishery studies, including those concerned with mortality and disease, sea lamprey control, cold- and warmwater population dynamics, general creel censuses, age and growth analyses, limnology of lakes and streams, fish toxicants, and aquatic plant control, all are expected to provide answers that will create increased future use of existing habitat, with increased efficiency. Studies designed to aid in the management of future wildlife populations include those on the effects of pesticides and herbicides on wildlife, tracking wildlife movement through radiotelemetry, evaluation of hunter success resulting from game management measures, analysis of inventory and population estimation methods, studies of farmland deer herds, and surveillance of diseases such as rabies, lead poisoning, and botulism.

(2) Development of new resources. In some areas in the Basin the fish and game habitat base available to the public could not support all future fishing and hunting net demands even if optimum use of these lands and waters was realized. In these cases it will be necessary to

develop or acquire new areas or introduce new stocks of hunting or fishing opportunity to support expected demands. There are several development programs now underway or being proposed that are expected to have an overall positive effect upon the Grand River Basin sportsman. The program now receiving national attention is the introduction of coho and chinook salmon into Lake Michigan. If expectations are realized, and results do appear encouraging, utilization of this new resource should be tremendous. Approximately 40 percent of the Nation's population resides in the industrial midwest, which borders the Great Lakes. The Great Lakes comprise by far the largest bodies of fresh water in the world. These comparatively undeveloped segments of fisheries habitat now appear to have a new future with attendant benefits for Basin anglers. The possible introduction of striped bass into Basin waters



The possible introduction of striped bass into Basin waters suggests another quality fishery.

also suggests another potential quality fishery. The striped bass and salmon have spawning habitat requirements that can be met by some streams in the Grand River Basin. If anadromous populations are established in Lake Michigan, the Basin angler should be able to fish spawning runs of salmon (fall) and striped bass (spring) near his residence. There may be certain stream obstructions that should be removed, if they are of no value, or fish passage devices built into the remaining structures to permit access to choice spawning areas. These programs will also require building or conversion of fish hatchery facilities to meet initial salmon or bass stocking requirements.

The construction of large and small reservoirs will be of benefit to many interests. The theory of multiple-purpose developments is often sound; however, in practice, single-purpose units also merit consideration. Over-development can be as inexcusable as under-development. A varity of recreational experiences can be provided by a complex of single or dual-purpose developments on a less cluttered and more easily managed scale, than by trying to plan each unit of the group as, "all things to all people". For example, a reservoir constructed to provide fishing opportunity requires optimum water depth during the summer, while a waterfowl reservoir is often best managed with low water levels during the summer to promote vegetation and increasing water depths in the fall to attract waterfowl and to partially flood food patches. Multiple-purpose reservoirs often provide a spectrum of conflicts and problems to the fish and wildlife manager, which often appear impossible to resolve. Some impoundment uses that are better developed on a single or dual-purpose basis are wetland or waterfowl impoundments, northern pike spawning marshes, and small fishing impoundments.

Construction of larger reservoirs in the Basin could possibly provide additional commercial fishing opportunity. Commercial operations in these waters will depend largely on the availability of markets and on legal restrictions. However, should carp and other non-game species become established in sufficient numbers, occasional commercial removal under supervision of the Michigan Conservation Department may be desirable. This possibility should be considered in future planning stages of water resources development in this Basin.

21. <u>DETAILED SUBAREA PLANS</u>

Plans specific to particular subareas are listed and discussed in the following portions of this report. In each subarea other agency plans for the near-future (1980) which are independent of this study, have been documented. However, there is no assurance what portion of these plans will actually be realized prior to 1980. Therefore, a spectrum of potential proposed projects resulting from this comprehensive study are recommended to planners to augment plans developed apart from this

study. Both projected and proposed plans are purposely flexible so that they may be integrated into the best comprehensive plan for meeting future fish and wildlife demands.

a. Grand Rapids Subarea.

(1) Projected plans. The acreage and preliminary use estimates, provided by projected state, county, and local fish and wildlife developments in the Grand Rapids Subarea for the interim 1965-1980 are:

Hunting	Acres	Net Days Use
Additions to Existing Game Areas	380	390
New Game Area	1400	1500
Scarce (Waterfowl) Habitat	200	130
State Parks or Recreation Areas	950	980
Secondary Waterfowl Habitat	320	200
TOTAL		3200

Fishing	Acres	Net Days Use
Farm Ponds	250	17500
Small Fishing Impoundments	25	880
Fishing and Park Lakes	44	1500
TOTAL		19880

(2) Proposed plans. Projects proposed and ultimately considered in this study, which would be of greatest benefit for meeting fish and wildlife demands in the Grand Rapids Subarea, are listed below in their order of recommended priority:

			Summer Pool		Net Days Use (Preliminary Estimate)	
Site Name & (No.)	Stream	Dam Site	Acres	Elev.	Hunting	Fishing
Rockford (19)	Rogue	T9R11, Sec. 25	3800	740	20700	83000
Bear Creek (21)	Bear	T8R10, Sec. 30	720	700	1700	25900
No Name (278A)	No Name	T9R10, Sec. 31	150	800	330	9000
Sand Creek (74)	Sand	T7R13, Sec. 27	1470	660	2900	40700
Ravenna #2 (16)	N. Br. Crockery	T9R14, Sec. 11	380	680	760	14200
Bass Creek (316)	Bass	T7R15, Sec. 25	230	615	500	9500
Deer Creek (18)	Deer	T7R14, Sec. 1	710	620	1300	20400
Norris Creek #2 (64)	Norris	T9R15, Sec. 21	430	640	760	15500
Rio Grande Creek (321)	Rio Grande	T9R14, Sec. 22	135	658	300	7800

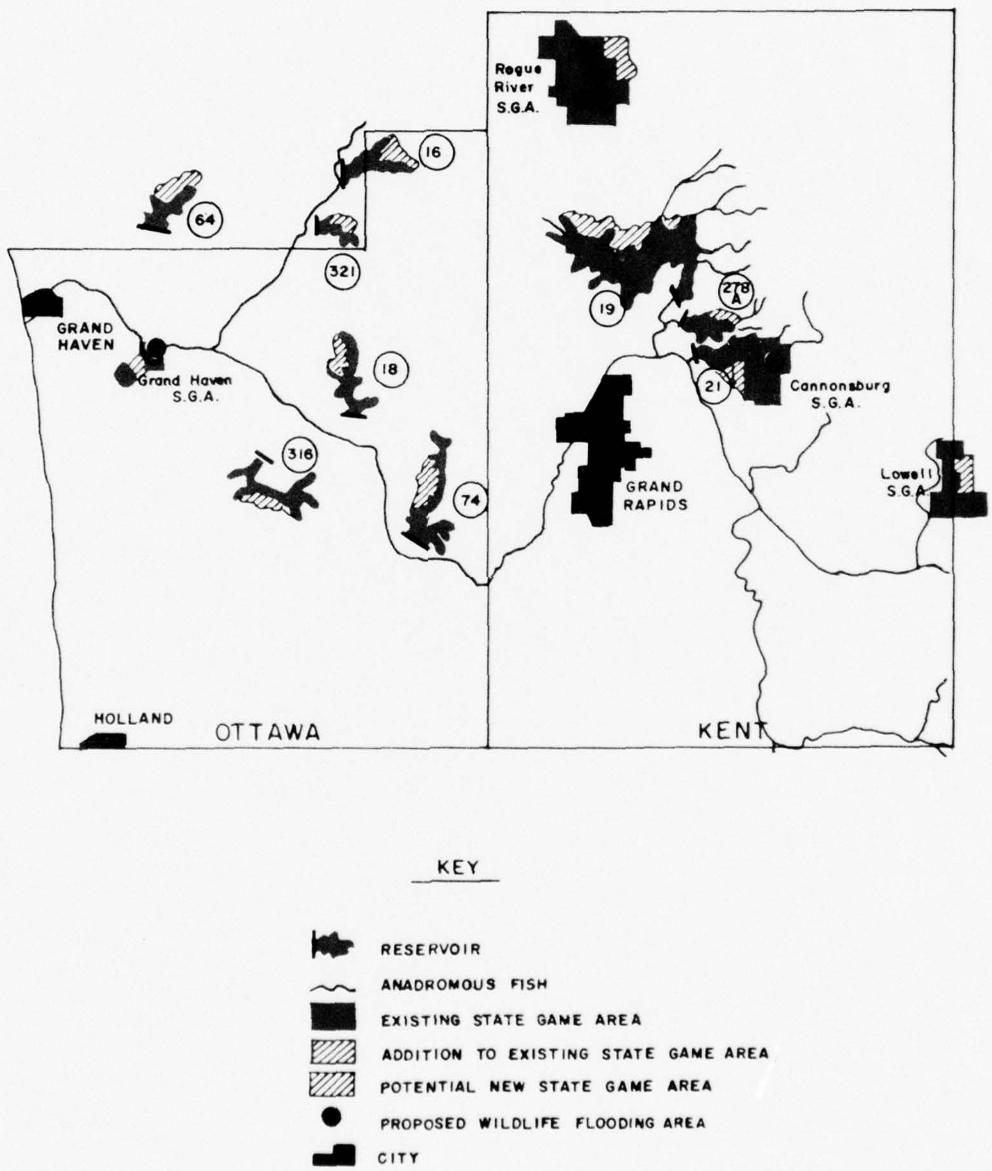
(3) Discussion. The Grand Rapids Subarea is estimated to need 84,900 additional angler-days opportunity by 1980, 236,300 by 2000, and 373,300 by 2020, to satisfy increasing demand (Table 9). An additional 117,700 hunter-days use will be required by the year 2000, and 281,100 days-use will be needed by 2020, over that available in 1960 (Table 10). These requirements do not consider that demand by subarea residents which must presently be met outside of the subarea.

The Michigan Department of Conservation plans to stress acquisition of public hunting lands in southern Michigan (29/21): "Plans call for gradual extension of ownership in present southern Michigan Game Areas where the State now owns only 45 percent of the land within boundaries. Three to five percent of these lands are proposed to be bought each year in a long-range program." Lands acquired throughout the Basin can provide deer, waterfowl and small game hunting. Michigan recreation resource planners (40) estimate that 4,750 acres will be added to existing Basin game areas and 18,000 acres will be purchased as new Basin game areas by 1980.

The ratio existing between subarea acreage to total Basin acreage was used to allot the projected Basin acquisition acreage to each subarea. The 380 acres assigned to the Grand Rapids Subarea could be added to Grand Haven, Rogue River, Cannonsburg, or Lowell State Game Areas (Figure 21). The ultimate or goal acreage (Table 6) for any of these areas would not be met, even if the entire 380 acres were purchased at a single area. Selection of areas of acquisition will depend on the State's management plans for each area, the availability of desired acres at particular areas, and acquisition costs. Indications are that an additional 1,400 acres of game area lands will be acquired to develop new public hunting areas in the Grand Rapids Subarea prior to 1980 if traditional acquisition patterns are adhered to. Game areas could be developed at minimum costs in conjunction with proposed Federal reservoir plans. There are several possible sites west of Grand Rapids, located in Ottawa County, which would be desirable for new game area development (Figure 21).

Projected purchases of scarce waterfowl habitat are expected to total 200 acres in the Grand Rapids Subarea, and 1,400 acres throughout the entire Basin. Selection of a potential area is governed by its relation to existing waterfowl habitat and its availability for purchase. Scarce wetland habitat may also be provided by water control structures regulated specifically for wetland management. These types of impoundments are scheduled to be constructed at State game areas throughout the Basin (41). The Grand Haven, Rogue River, and Cannonsburg areas are scheduled for wetland development (Table 11 and Figure 21) in the Grand Rapids Subarea. If these impoundments are built at comparable size to those previously constructed by the State, they will be of a size (average five acres) which facilitates management.

FIGURE 21 GRAND RAPIDS SUBAREA PLANNING PROPOSALS TO MEET 1980 DEMANDS



State Park or Recreation Area lands are estimated to increase by 12,000 acres throughout the Basin by 1980, of which 950 acres have been tentatively allocated to the Grand Rapids Subarea. If hunting is allowed in future years on this land, potential usage could be significant in meeting future planning area demands. The assumption was made that fall hunting would be permitted on these new park lands, at least until the year 1980.

Secondary waterfowl habitat and the hunting it sustains will be provided by farm ponds, small fishing impoundments, and fishing and park lakes.

Projections of farm pond construction prior to 1980 have been extrapolated from annual county construction totals occurring from Fiscal Year 1963 through Fiscal Year 1966 (42). Assuming that construction rates in Ottawa and Kent Counties continue at these derived rates through 1980, 250 acres of water will be provided by 500 Subarea farm ponds. Farm ponds could satisfy an estimated 17,500 annual angler-days use. This figure does not include angler use of irrigation storage reservoirs, or irrigation pits or regulating reservoirs. Most farmers and/or landowners enjoy the added rewards of managing their ponds for fishing. Whether or not the pond is opened to the public for fishing, the sustained construction of farm ponds will serve to reduce fishing intensity on public fishing waters.

About 1,600 acres of State constructed small fishing impoundments and larger fishing and park lakes are programmed for Basin development prior to 1980. This figure may become larger if projective programs are accelerated. In the Grand Rapids Subarea, at least an additional 70 acres of this type of habitat might be expected before 1980. Locations have not been selected, but smaller impoundment sites are listed in the Grand Rapids Subarea's proposed plans sub-section. We assume that all reservoir developments will be provided with adequate access facilities to the impoundment and its tailwater.

The nine sites (Figure 21) proposed for future development were selected from 20 Corps of Engineers and/or Soil Conservation Service potential impoundments under consideration in the Grand Rapids Subarea. Some of these nine sites do not presently have adequate flood control and allied benefits for immediate construction as multiple-purpose projects, but they would provide immediate single-purpose fish and wildlife developments. Many of the sites located near Grand Rapids will be developed by other interests if these reservoirs, or the lands necessary for their development, are not acquired in the very near future. Recreation sites, near this growing urban complex, will increase tremendously in value with each passing year.

The Rogue River or Rockford Site, designated as Site 19 by the Corps of Engineers (34/2), was selected as having outstanding potential for

fish and wildlife development. Other participating agencies have also shown considerable interest in this site, enhancing its potential for multiple-purpose development. The dam site is located $\frac{1}{2}$-mile north of Rockford, and approximately 10 miles northeast of Grand Rapids (Figure 21). From present data, the normal summer (conservation) pool would be approximately 4,300 acres and this pool's depth at the dam would be 46 feet. The Rogue River presently has anadromous fish potential, but it is questionable that this potential could be realized due to rapid industrial and residential development of its lower reaches. This potential reservoir would appear to have the water quality and depth necessary for considering landlocked kokanee salmon introduction supported by spawning areas in the upstream tributaries. Upland game habitat surrounding this reservoir and waterfowl areas within the reservoir area would provide considerable hunting opportunity.

The remaining eight sites (Figure 21) all have potential for fish and/or wildlife development. Those having higher priority ratings should be considered before the sites are taken by other interests. Sites 21, 278A, and 74 fall into this category.

The anadromous fish development program should have a considerable, but yet undetermined, effect on satisfying near-future (1980) angler demands in the Grand Rapids Subarea. All spawning runs passing into the Grand River Basin will pass through this Subarea. The Lower Coldwater and Thornapple Rivers are expected to have especially suitable spawning habitat for anadromous fish populations in the Grand River Basin (Figure 21).

b. West Central Belt Subarea Plan

(1) Projected plans. The projected fish and wildlife developments in the West Central Belt Subarea, for the interim 1965-1980, are listed below. The acreage and preliminary use estimates that would be provided by these developments are:

Hunting	Acres	Net Days Use
Additions to Existing Game Areas	2100	2200
New Game Areas	8100	8300
Scarce (Waterfowl) Habitat	370	230
State Parks or Recreation Areas	5400	5600
Secondary Waterfowl Habitat	360	220
TOTAL		16550

Fishing	Acres	Net Days Use
Farm Ponds	320	22400
Small Fishing Impoundments	41	1400
TOTAL		23800

(2) Proposed plans. The following reservoir sites were selected as having the greatest potential for meeting future fish and wildlife demands in the West Central Belt and surrounding subareas:

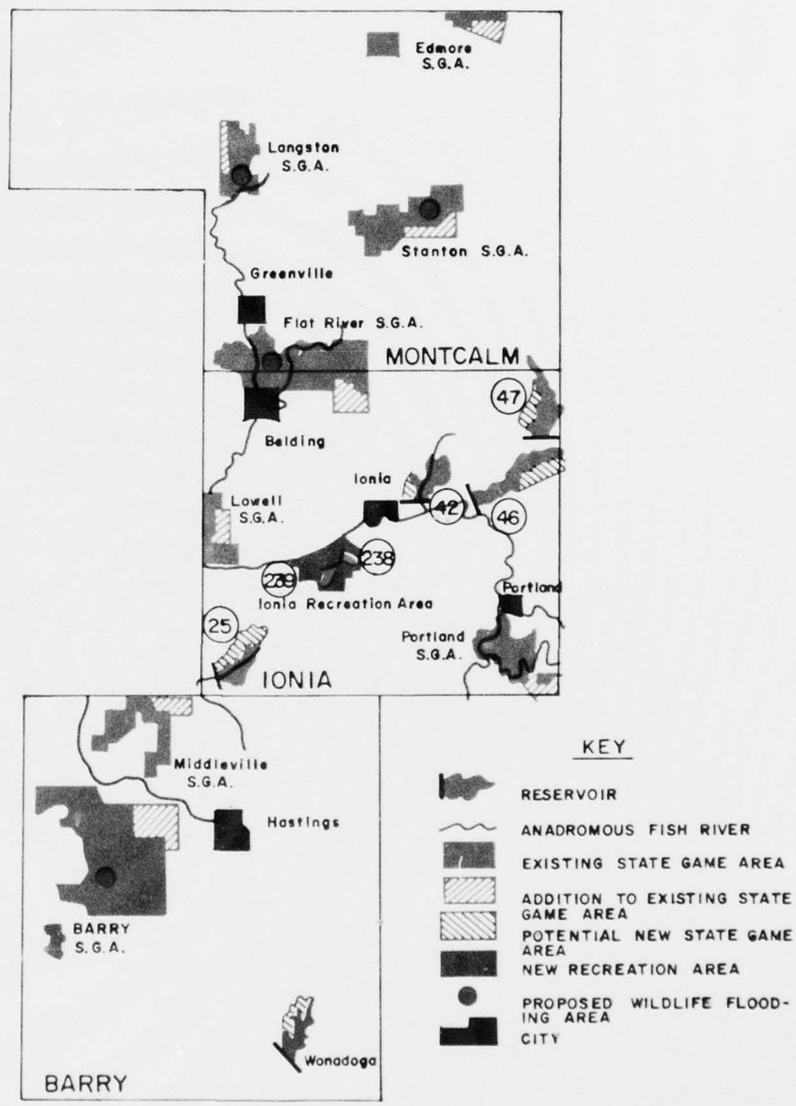
			Summer Pool		Net Days Use (Preliminary Estimates)	
Site Name & (No.)	Stream	Dam Site	Acres	Elev.	Hunting	Fishing
Sessions Creek (239)	Sessions	T7R7, Sec. 34	220	720	700	15800
Prairie Creek (42)	Prairie	T7R6, Sec. 16	920	738	2800	29000
Fish Creek (47A)	Fish	T9R5, Sec. 35	2300	747	16400	65700
No Name (238)	No Name	T7R7, Sec. 35	50	710	300	3500
Duck Creek (25)	Duck	T5R8, Sec. 29	940	820	2500	26000
Muir (46)	Maple	T7R5, Sec. 9	2300	644	19400	15000
Wonadoga (-)	Wonadoga	T1R7, Sec. 26	700	855	2100	16100

(3) Discussion. The West Central Belt Subarea has projected net demands of 36,300 angler-days by 1980, 219,200 by 2000, and 427,300 angler-days by 2020, in excess of the opportunity available in 1960 (Table 9). Net demands for hunting will approach 70,000 days-use by 2000 and 154,100 by 2020 in excess of that which was sustained by 1960 opportunity (Table 10). These figures do not consider that entire portion of net demand from adjacent subareas that has been supplied by this Subarea in past years. This Subarea can be expected to have to supply increasing demands from Grand Rapids, Lansing, and Jackson, as their urban complexes grow.

The Michigan Department of Conservation has acquired nearly one-half of its goal in developing public hunting acreage within the West Central Belt Subarea (Table 6). We expect this general trend will continue because the lands in this subarea are less intensively farmed and more suitable and less costly for game management development than in other subareas. State game areas located in this Subarea are also easily accessible from population centers to the east, west, and south. If past acquisition trends are maintained, 2,100 public hunting areas will be added to existing sites: i.e., Middleville, Barry, Portland, Lowell, Flat River, Stanton, Edmore, and Langston State Game Areas (Figure 22). Remaining goal acreage for these areas totals 38,400 acres (Table 6). The State's management plans for each area, the availability of goal acres at particular areas, and the per-acre cost will determine which areas will receive priority for acquisition.

Approximately 8,100 acres of public hunting habitat could be acquired at new areas within the West Central Belt Subarea. Because of the

FIGURE 22. WEST CENTRAL BELT SUBAREA PLANNING PROPOSALS TO MEET 1980 DEMANDS



Subarea's wealth of good reservoir sites and the need for such sites in the near future, primarily from adjacent subareas, it is quite possible that new game areas could be acquired in conjunction with Corps of Engineers reservoirs.

Scarce waterfowl habitat purchases or developments are expected to approach 370 additional acres by 1980. Selection of a potential area is governed by its relation to existing waterfowl habitat and its availability for purchase. Small water control structures, constructed specifically for the benefit of wildlife and waterfowl, are scheduled for development at the Langston, Flat River, Barry, and Stanton areas in the Subarea (Table 11 and Figure 22).

Secondary waterfowl habitat and the hunting it sustains will be provided by farm ponds and small fishing impoundments. A total of 360 acres of habitat having secondary potential for waterfowl are projected for development prior to 1980. Additional acreage would be provided by the construction of proposed reservoirs.

State Park or Recreation Area lands are estimated to increase by 5,400 acres in the West Central Belt Subarea by 1980. The Ionia Recreation Area (Figure 22) is expected to provide approximately 3,300 acres of huntable land, or 60 percent of this projected figure.

Farm pond construction during the interim 1960-1980 is expected to approximate 320 acres. This acreage could satisfy about 22,000 angler-days use, and reduce fishing intensity on public waters. Small fishing impoundments are expected to add an additional 40 acres of water which could support approximately 1400 angler-days use.

The Ionia Recreation Area has been dedicated and is expected to contain two lakes, Sites 238 and 239 (Figure 22). A general recreation lake of approximately 220 acres could be provided at Site 239, and a coldwater lake of 50 acres could be managed for trout at Site 238. The Department of Conservation's Fishery Division is considering a fishing lake at Site 25. This lake, on Duck Creek, would be managed as a warmwater fishery, but it might have additional potential by supplying a sustained fall flow for anadromous fish runs. The Wonadoga Creek site has been identified as worthy of study as to possible inclusion in the State Lakes Program. While outside of the Basin's hydrographic boundary, it lies within the Basin study area.

Sites 42 on Prarie Creek and 47A on Fish Creek have excellent possibilities for high quality fisheries of considerable magnitude. Hunting potential, particularly for upland game species, is also above average at these sites. The Muir Site, Number 46, has extremely high potential for waterfowl development. This site has been placed toward the lower end of this select

reservoir list. However, it could be elevated considerably if reservoir operations were regulated to optimize its waterfowl potential. The Muir Site would provide a logical refuge and adjacent hunting area for waterfowl traveling from the Shiawassee Flats National Wildlife Refuge area on down the Mississippi Flyway.

The Grand, Flat, Thornapple, and Coldwater Rivers are expected to have a major impact on anadromous fish populations in future years (Figure 22). The magnitude of use in these rivers has not been determined at this time, but the opportunity they are expected to provide should satisfy many West Central Belt Subarea anglers.

c. Lansing Subarea

(1) Projected plans. The acreage and preliminary use estimates provided by projected fish and wildlife developments in the Lansing Subarea for the interim 1965-1980 are:

Hunting	Acres	Net Days Use
Addition to Existing Game Areas	630	650
New Game Areas	2400	2500
Scarce (Waterfowl) Habitat	370	230
State Parks or Recreation Areas	2100	2200
Secondary Waterfowl Habitat	440	270
TOTAL		5850

Fishing	Acres	Net Days Use
Farm Ponds	400	28000
Small Fishing Impoundments	42	1500
TOTAL		29500

(2) Proposed plans. The following potential sites were selected from 27 Corps of Engineers reservoirs, 20 Soil Conservation Service impoundments, and several Michigan Department of Conservation sites which had been located within the Lansing Subarea. These 11 sites are recommended for further consideration and are listed in their order of recommended priority because of their potential for satisfying future hunting and sport fishing demands.

Site Name & (No.)	Stream	Dam Site	Summer Pool Acres	Summer Pool Elev.	Net Days Use (Preliminary Estimate) Hunting	Net Days Use (Preliminary Estimate) Fishing
Portland (51)	Looking Glass	T6R5, Sec. 34	1200	749	3700	31400
Doan Creek (59)	Doan	T3R2, Sec. 17	2710	900	5300	46800
Sleepy Hollow (110)	Little Maple	T7R1, Sec. 34	550	790	2200	14300
Hayworth Creek (67)	Hayworth	T8R3, Sec. 18	250	690	4200	16800
Elsie (49)	Maple	T8R1, Sec. 11	500	705	1460	13900
Columbia Creek (144)	Columbia	T2R3, Sec. 7	200	885	650	10800
Okemos (57)	Red Cedar	T4R1, Sec. 27	970	860	2300	21000
No Name (180)	No Name	T3R5, Sec. 2	750	880	2200	20700
Lacey Creek (179)	Lacey	T2R6, Sec. 24	1050	895	3000	25200
Hobart Creek (142)	Hobart	T1R3, Sec. 10	120	895	330	6000
Bad Creek (162)	Bad	T7R3, Sec. 34	425	740	1240	13300

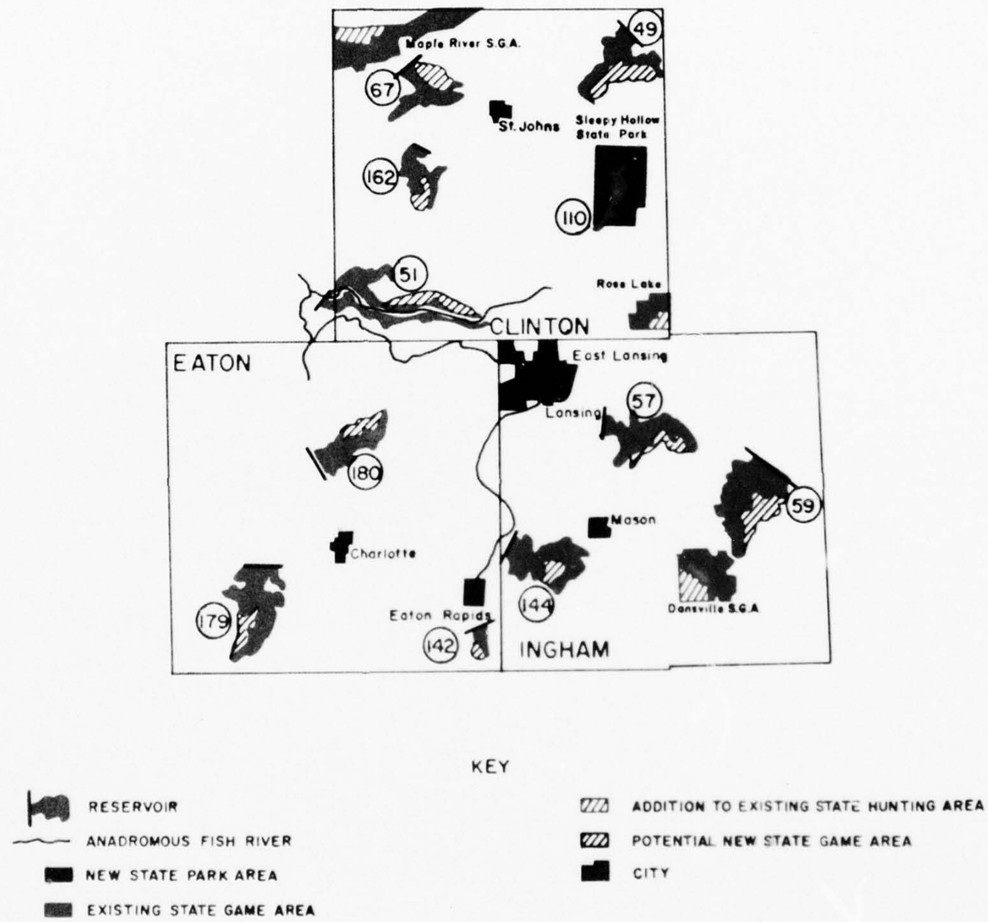
(3) Discussion. Net fishing demands are expected to amount to 192,500 angler-days use by 1980, 306,500 by 2000, and 438,200 by 2020, over that which can be met by opportunity existing in the Lansing Subarea in 1960 (Table 9). Net hunting demand, when compared to 1960 opportunity, will be deficient by 145,000 hunter-days use in 2000 and 327,900 days use by 2020 (Table 10).

The Maple River, Dansville, and Rose Lake public hunting areas now exist in the Lansing Subarea (Figure 23). We estimate that approximately 630 acres of additional land will be acquired for these areas prior to 1980. The goal acreage now needed to fully "block-out" Subarea public hunting sites is 8,700 acres (Table 6). The Michigan Department of Conservation will judge where additional acres would be of greatest value to Lansing Subarea hunters.

If traditional acquisition patterns are adhered to, approximately 2,400 acres of game area lands will be purchased at new sites in the Lansing Subarea prior to 1980. Game areas could be developed near a number of the proposed reservoir sites located on Figure 23.

Projected purchases of scarce waterfowl habitat are expected to total 370 acres in the Lansing Subarea. If purchase areas are not available, water control structures can be developed to provide needed wetland

FIGURE 23. LANSING SUBAREA PLANNING PROPOSALS TO MEET 1980 DEMANDS



habitat. This type of small impoundment might be constructed in the Clinton County portion of the Maple River State Game Area or at other Subarea sites having suitable habitat and topography. Water control structures are scheduled for construction in the Gratiot County portion of the Maple River area (Table 11 and Figure 24). There is also the possibility of developing the Muir Site on the Lower Maple River primarily for waterfowl (Figure 22).

Secondary waterfowl habitat will be developed at farm ponds and small fishing impoundments. Although these waters usually do not attract large flights of waterfowl, they are expected to provide approximately 300 annual waterfowl hunter-days use by 1980.

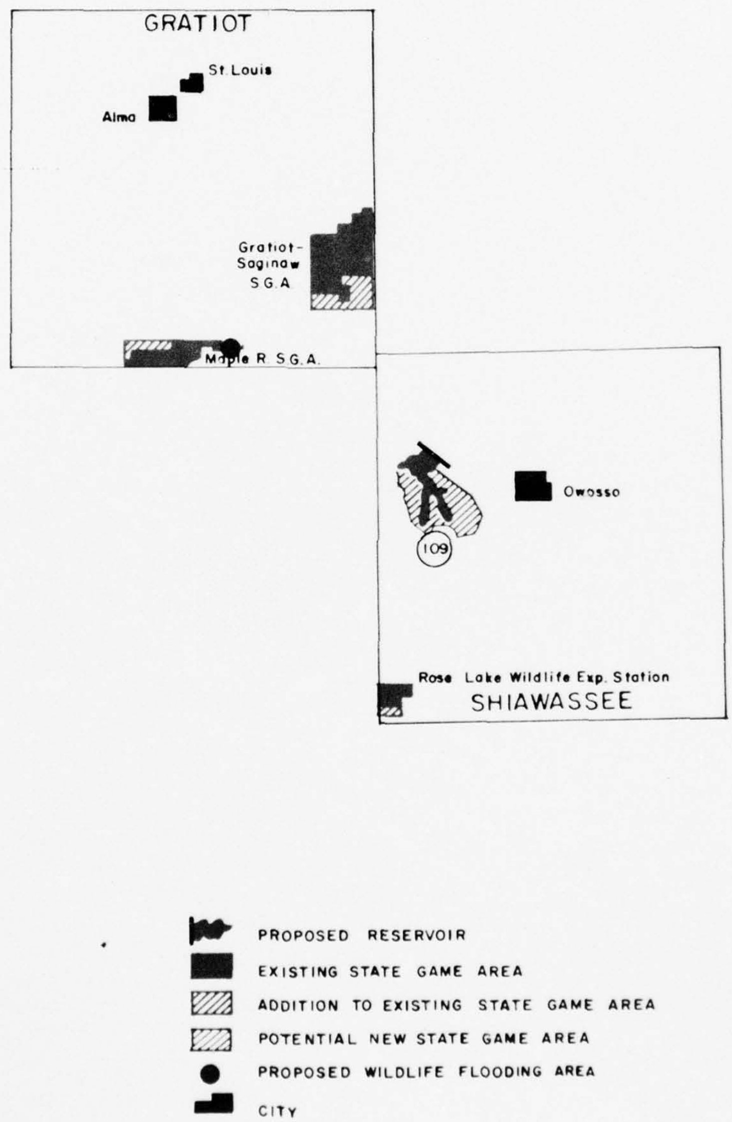
Sleepy Hollow State Park (Figure 23) is planned to contain nearly 2,100 acres of land, in addition to a 550-acre reservoir (Site 110). We assume that fall hunting will be permitted on these lands, at least until the year 1980. If this assumption is correct, Sleepy Hollow State Park will provide an estimated 2,200 hunter-days use per year.

There were five Corps of Engineers reservoir sites of 27 potential sites and six Soil Conservation impoundments of 20 potential sites in the Lansing Subarea that appeared to be especially well suited for satisfying future hunter and angler demands. We believe that several of these sites would also be valuable for other agency uses.

There is interest in providing flood control and low-flow augmentation relief for the cities of Lansing and East Lansing. The flow augmentation method of reducing pollution problems during periods of low stream flows is at best a temporary remedial measure. Pollution should be abated at its source. Sites 57 and 59 appear to offer the greatest potential for fish and wildlife upstream from Lansing. Site 57, at Okemos on the Red Cedar River, and Site 59, on Doan Creek, lie in the Red Cedar drainage area, which is located south and east of Lansing (Figure 23). Zorb (43/138-140), in his analysis of five Red Cedar drainage sites, stated that the Okemos Site "is probably the best site of the 5 for recreational purposes" and the Doan Creek Site "is probably the most realistic in view of land acquisition problems". In summarizing his appraisal of the five sites, Sycamore Creek (55), Mud Creek (56), Okemos (57), Williamston (58), and Doan (59), he stated:

> "It is poor land management to use the potential reservoir land to postpone more complete sewage treatment in Lansing. The sites selected for possible reservoirs by the Water Resource Commission would probably serve a better social purpose if they were to be developed primarily for recreation. Such a plan might call for developing 4 of the proposed sites - dropping the Williamston site because of site cost and low quality basin. The Okemos

FIGURE 24. NORTHEAST FRINGE SUBAREA PLANNING PROPOSALS TO MEET 1980 DEMANDS



site would be developed for a high use recreational area, the Sycamore and Doan Creek sites developed for less intensive recreational use (hunting, fishing, limited camping) and the Mud Creek Basin held for emergency low-flow augmentation. These basins could augment the flow of the Grand in case of emergencies or accidental contamination and could serve flood control purposes in a limited extent."

The maximum depth at the dam of Site 57 (Okemos) would be 29 feet, with the normal summer (conservation) pool depth at the dam approximately 19 feet. Water depths at the Site 59 dam would be 30 feet with a non-fluctuating pool. The estimated summer pool acreages would be 760 acres at Site 57 and 2,600 acres at Site 59. Preliminary estimated fishery benefits could reach 21,000 annual angler-days use at Site 57 and 47,000 days use at Site 59, if the reservoir and tailwater fisheries were developed to full potential at each site. Waterfowl and upland game preliminary benefits, using game area and park lands, would approximate 2,300 days use at Site 57 and 5,300 days use at Site 59, if each site were fully developed.

Site 51, located east of Portland on the Looking Glass River, also would provide necessary opportunity to hunters and fishermen using Lansing Subarea resources (Figure 23). The Portland Reservoir would have a summer pool depth of 38 feet at the dam, with 40 percent of the pool having depths averaging about 30 feet. Surface acreage at this site would be approximately 1,200 acres. With full development of the site's fish and wildlife potential, preliminary utilization estimates would be 31,000 annual angler-days and 3,700 annual hunter-days.

Subarea farm pond construction is expected to total 400 acres prior to 1980 if present construction rates are maintained. We estimate that this acreage could provide 28,000 annual days use for fishermen.

There are several fishing and park lake developments proposed in the Lansing Subarea for the interim 1965 to 1980. The Sleepy Hollow State Park has been dedicated, and plans call for a 550-acre lake (Site 110) formed by a 27-foot dam on the Little Maple River (Figure 23). The Conservation Department's Fishery Division has proposed a 120-acre lake, impounded by a 25-foot dam on Hobart Creek (Site 142). These two developments could annually provide about 25,000 angler-days use.

The remaining six sites noted as "optional" choices are located on Figure 24 and, in our opinion, are also worthy of consideration for fishing and park lake or multiple-purpose development. Site numbers 144, 180, 179, 67, 162, and 49 have been analysed at those elevations where fishery potentials would be maximized and induced damages to agriculture would be minimized. The S.C.S. structures in this group do not presently have

a favorable benefit-cost ratio based on traditional purposes, but would provide sites for State single purpose fish and wildlife developments.

The anadromous fish development program will have an effect on satisfying near-future (1980) angler needs in the Lansing Subarea, but to what degree is yet undetermined. The Grand and Looking Glass Rivers are expected to be utilized by anadromous fish populations in this Subarea prior to 1980 (Figure 23).

d. Northeast Fringe Subarea Plan

(1) Projected plan. The projected fish and wildlife developments in the Northeast Fringe Subarea, for the interim 1965-1980, are listed below. The acreage and preliminary use estimates that could be provided by these developments are:

Hunting	Acres	Net Days Use
Additions to Existing Game Areas	660	680
New Game Areas	2500	2600
Scarce (Waterfowl) Habitat	260	160
State Parks and Recreation Areas	1700	1700
Secondary Waterfowl Habitat	180	110
TOTAL		5250

Fishing	Acres	Net Days Use
Farm Ponds	170	11900
Small Fishing Impoundments	14	490
TOTAL		12390

(2) Proposed plans. The following site was the only potential reservoir in the Basin portion of the Northeast Fringe Subarea that appeared to have high fish and wildlife values. Potential sites in Shiawassee and Gratiot Counties, that were outside of the Grand River Basin's hydrologic boundary, are not identified.

			Summer Pool		Net Days Use (Preliminary Estimate)	
Site Name & (No.)	Stream	Dam Site	Acres	Elev.	Hunting	Fishing
Bear Creek (109)	Bear	T7R1, Sec. 26	235	760	2600	8700

(3) Discussion. Although the Northeast Fringe Subarea has estimated net hunting and fishing demands that are not as great as other

subareas, planning should be carefully considered to take advantage of the available terrain and habitat. Net fishing demands are expected to require additional fishing habitat over that available in 1960 (Table 9) to sustain an additional 21,000 angler-days use by 1980, 52,700 by 2000, and 88,500 days use by 2020. The hunting opportunity available in this Subarea in 1960 will have to be increased to sustain an additional 52,800 hunter days in 2000 and 118,300 days use by 2020 to satisfy net hunter demands.

The projected acquisition for existing public hunting areas is 660 acres. This could be added to the established Rose Lake, Maple River, and/or Gratiot-Saginaw areas (Figure 24). The goal acreage for these three areas is 15,200 acres. Selection of where purchases should be made will depend on the State's management plans for each area, the availability of goal acres at particular areas, and the per-acre cost.

If Bear Creek (Site 109) should be constructed as a fishing lake, the 2,500 acres projected to be acquired for new game areas could be developed at this site (Figure 24). If plans should call for Bear Creek to be developed as a park lake, the 1,700 acres projected to be acquired for parks or recreation areas could be provided with this project. The 2,500 acres allocated to new game areas might be of greater value, with less operation and maintenance costs, if they were added to established areas which require expansion.

Projected purchases of scarce waterfowl habitat are expected to total 260 acres in the Northeast Fringe Subarea. Selection of a potential area is directed by its relation to existing waterfowl habitat and its availability for purchase. Scarce waterfowl habitat may also be provided by water control structures regulated specifically for wetland management. Such structures are programmed for construction in the northeastern portion of the Maple River State Game Area (Figure 24). Waterfowl habitat, on a less intensively managed scale, will be provided by fishing developments (farm ponds, fishing and park impoundments).

Preliminary hunting use estimates on the projects discussed above would approach approximately 5,300 hunter days, if all sites were fully developed.

Farm ponds will provide a great amount of angler opportunity if present construction rates are maintained through 1980. We estimate that nearly 12,000 annual angler-days use could be provided by 170 acres of this type of habitat within the Northeast Fringe Subarea.

One fishing or park lake development is proposed in the Northeast Fringe Subarea for the interim 1965 to 1980. An impoundment could be formed at Site Number 109 (Figure 24) by placing a 30-foot dam on Bear Creek in Section 26, Township 7N, Range 1E. This dam would provide a 235-acre lake if the water surface were at elevation 760 feet. The

impoundment and tailwater fishery, if developed fully, would provide an estimated 8,700 angler-days use annually.

e. Jackson Subarea Plan

(1) Projected plans. The acreage and preliminary use estimates provided by projected fish and wildlife developments in the Jackson Subarea for the interim 1965-1980 are:

Hunting	Acres	Net Days Use
Addition to Existing Game Areas	950	980
New Game Areas	3600	3700
Scarce (Waterfowl) Habitat	200	120
State Parks or Recreation Areas	2400	2500
Secondary Waterfowl Habitat	220	140
TOTAL		7440

Fishing	Acres	Net Days Use
Farm Ponds	100	7000
Small Fishing Impoundments	11	380
Fishing and Park Lakes	110	3900
TOTAL		11280

(2) Proposed plans. The following reservoir sites were selected from nine Corps of Engineers and ten Soil Conservation Service impoundments located in the Jackson Subarea as having the greatest potential for fulfilling future hunting and fishing demands:

			Summer Pool		Net Days Use (Preliminary Estimate)	
Site Name & (No.)	Stream	Dam Site	Acres	Elev.	Hunting	Fishing
Sandstone Creek (62)	Sandstone	T1R3, Sec. 28	5900	950	16100	72600
Smithville (73)	Grand	T1R3, Sec. 2	2290	890	6700	38800
Liberty (10)	Grand	T4R1, Sec. 27	510	1020	1500	16500
Portage River (171)	Portage	T1R2, Sec. 21	2200	920	10800	8800
Spring Brook #1 (60)	Spring	T1R3, Sec. 3	2220	930	7800	28900

(3) Discussion. By 1980, unfulfilled demand for fishing in the Jackson Subarea is estimated to require additional habitat to sustain

148,600 angler-days use (Table 9). Projections of these demands indicate that a deficit of 315,700 angler days will exist by 2000 and 497,200 angler days by 2020. Net hunting demand is estimated to have a hunter-day use deficit of 58,700 by 2000 and 126,400 by 2020, over that being satisfied in 1960.

The Waterloo Recreation Area and Sharonville State Game Area presently provide public hunting opportunity for Jackson Subarea users (Figure 25). We estimate that approximately 950 acres will be added to these areas prior to 1980. The goal acreage needed to fully "block-out" the Sharonville Area is 3,300 acres (Table 6).

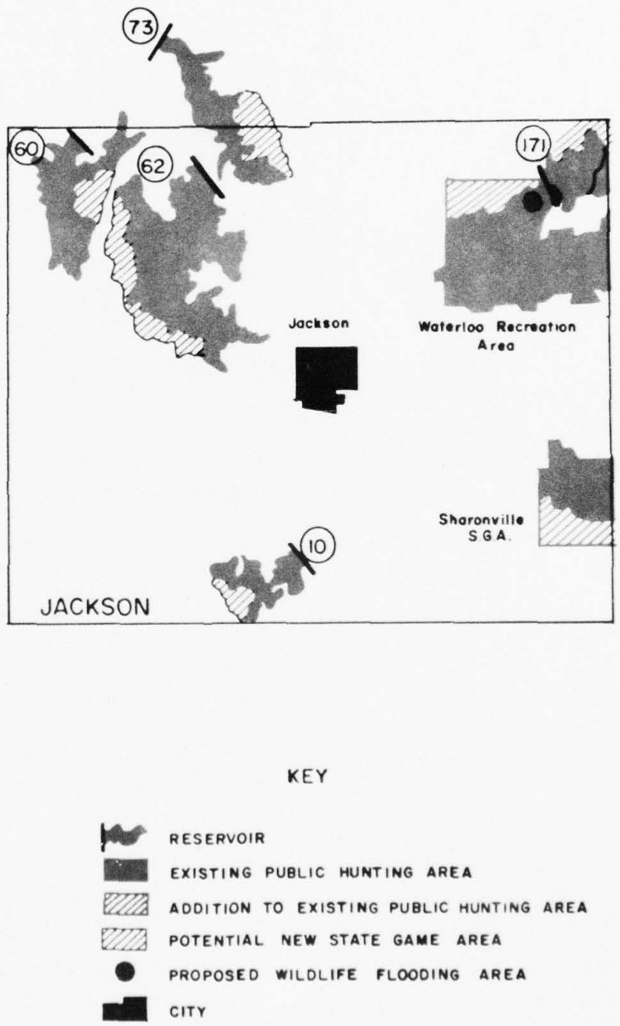
Past acquisition patterns indicate that approximately 3,600 acres of public hunting lands will be acquired at new sites in the Jackson Subarea prior to 1980. Game areas of this magnitude could be developed in conjunction with various State or Federal reservoir option sites shown on Figure 25.

Projected purchases of scarce waterfowl habitat may total about 200 acres in the Jackson Subarea. Small water control structures, built specifically to impound waters to benefit wildlife and waterfowl, are scheduled at the Waterloo Recreation Area (Table 11 and Figure 25). Waterfowl habitat in this area is excellent and should be managed to its full potential. Potential reservoir sites, CE-7, CE-8, and CE-63 (34/1 and 7) would flood a large portion of the Waterloo Recreation Area, causing irreparable losses of fish and wildlife habitat, unique ecological areas, outdoor recreation developments, and the attendant enjoyment of these resources. However, Site 171 on the Portage River, has been identified by the Michigan Department of Conservation as having substantial waterfowl potential. Site 60, on Spring Brook, would also have high waterfowl potential.

We estimate, using past trends, that approximately 2,400 acres will be added to park and recreation areas within the Jackson Subarea. An expansion of the Waterloo Recreation Area could easily absorb this acreage, and would be a good conservation investment for future years.

The Sandstone Creek Site (Site No. 62) was selected as having the best potential for fish and wildlife development. This site is located south of Tompkins Center and would inundate areas within 4 miles of the western edge of Jackson (Figure 25). It would impound about 5,500 surface acres of water during the summer and would have an average depth exceeding 15 feet. Preliminary estimates of use amount to 72,600 annual angler-days, predicated upon proper development and management of the reservoir and tailwater fisheries. Waterfowl and upland game preliminary benefits could total about 16,100 hunter-days use each year if a State game area and park lands were developed.

FIGURE 25. JACKSON SUBAREA PLANNING PROPOSALS TO MEET 1980 DEMANDS



Subarea farm ponds are expected to provide 100 acres of fish and wildlife habitat if present construction rates are maintained. This acreage could provide 7,000 annual angler-days use and also reduce fishing intensity on public fishing waters.

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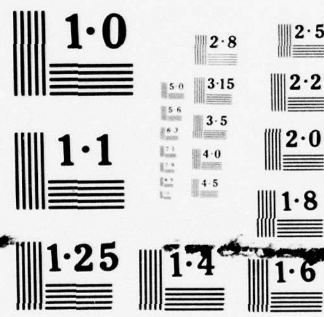

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SECTION VI

COST ESTIMATES FOR FISH AND WILDLIFE PLANS

Preliminary use estimates on projected Basin fish and wildlife developments are about 38,000 hunter days and 87,000 angler days. An additional 386,000 days of fishing opportunity will be required throughout the Basin to meet net fishing demands projected to be present by 1980. These angler demands could be satisfied by developing various proposed reservoir sites. A summary of average estimated costs for these various types of fish and wildlife developments is presented in the following pages. Costs will range above or below those estimated, depending on local conditions, and therefore, can not be used as firm estimates of any particular project.

Cost consideration in this study is limited to direct costs. Indirect costs such as those which are incurred by State or National research programs and the many general but associated programs of resource management and elements of initial effort on a local, State, or National level are not included. It would be unrealistic to attempt to assay fish and wildlife program costs beyond the near future on an existing dollar value.

22. COSTS OF FUTURE PROGRAMS

a. Fisheries. The total fishery development program by 1980 will have to create opportunities to sustain approximately 500,000 angler-days use which were not present in 1960.

Approximately 87,000 angler days, of the nearly 500,000 needed, are projected to be met under the farm-pond program. Little or no costs are directly allocated to fish and game interests as a result of accommodating anglers on this type of habitat, except for the cost of initial fish stocking, which is minimal. Construction of farm ponds is usually dependent upon the individual landowner and the U.S. Department of Agriculture, Stabilization and Conservation Service.

Farm ponds average about $\frac{1}{2}$ acre in size in the Grand River Basin; and initial costs for $\frac{1}{2}$-acre ponds would require approximately 60 percent of those costs given for a one-acre pond. Using estimates developed by Regier (44), the 2,480 farm ponds expected to be developed within the Basin from the present to 1980 would initially cost nearly $2.9 million dollars to build and $90,000 to stock with bass and bluegills. The annual amortized cost would be $95,000 to build and $2,900 to stock; with only the stocking being a federal or state cost.

The Michigan Department of Conservation (29) estimates that small fishing lakes and large fishing or park lakes cost about $3,400 per acre for initial land and development costs throughout the State. The total annual State cost of this projected program of State developed lakes

would be about $280,000 for the Grand River Basin. Certain of these developments could be cost-shared under the Soil Conservation Service Small Watershed Program (PL-566) reducing the amount of State funding required. If State lake development plans become a reality, the program would provide 77,000 angler-days use annually at present per-acre fishing pressures.

New public water access sites will cost about $30,000 per site in southern Michigan (39). This figure includes access roads, land, drives and parking, a concrete boat launching ramp, a boat dock, grading, landscaping, fencing, and toilets. Rehabilitation of older access sites costs approximately $8,700 per site. This figure includes access roads at 10% of costs for new roads, and site development at 50% of the cost of a new site. Most existing Basin sites are scheduled to be improved, and a large number of new Basin sites will be developed before 1980.

Annual costs at Corps of Engineers reservoir developments range between 10 and 40 cents per angler-day use, depending upon the level of development at a particular site. Those costs allocated to fisheries will be equally divided between the Federal construction agency and the State Conservation Department. Costs are based on annual equivalents of initial costs plus operation and maintenance costs.

It is reasonable to assume that the projected net demand of 386,000 man-days of fishing will either be met by increasing the level of use on the habitat projected to be available in 1980, or that proposed reservoir sites will be constructed to accommodate demand. If the latter course is deemed advisable, the cost of that opportunity created will depend on the construction agency providing the impounded water, land costs in the project area, relocation costs, the topography and soils of the reservoir site, and other related factors. The average annual costs would, however, be similar to those already noted.

The anadromous fisheries program is expected to be a vital factor in meeting projected unsatisfied fishing demands by 1980. The Michigan Department of Conservation has programmed $12 million in the next ten years for Great Lakes and anadromous fishing development and an additional $15.9 million for stream improvement throughout the State (29).

The total cost of supplying Basin fishing demands by 1980 will depend upon the methods selected by the Michigan Department of Conservation and the Grand River Basin Coordinating Committee as being most suitable for supplying opportunity to present and future fishermen. An estimate of annual amortized costs might total approximately $480,000 for the Basin's fisheries program developed by 1980 if it were to meet expected demands. Portions of this amount would be cost-shared with resource-oriented Federal agencies.

It would be unrealistic to attempt to estimate fishery program costs beyond 1980.

b. Wildlife. The hunting opportunity projected to be provided within the Basin by 1980 should create opportunity to supply an additional 38,000 hunter days. Much of this opportunity will be created in conjunction with water development projects, with additional gains occurring in routine acquisition of State game, recreation, or park lands. Conversely in the interim 1960 to 1980, approximately 37,000 hunter-days use will be lost through elimination of existing hunting habitat through land use changes.

Of the 38,000 hunter days gained by 1980, nearly 24,000 will be supplied annually on State owned and operated public hunting developments within the Grand River Basin. The average cost of land acquisition at new and existing Basin game areas is expected to be about $170 per acre for the next 10-year period, including costs incidental to land acquisition (40). Development costs are expected to average approximately $20 per acre, bringing the total cost to $190 per acre. Initial amortized costs for the 22,720 acres expected to be acquired and developed in the Basin at new and established public hunting areas will total about $140,000 annually. The State's costs for buying and managing these lands will be partially offset by Pittman-Robertson wildlife restoration funds and by share-cropping wildlife food plots on public hunting lands.

Considering hunter use, hunter associated uses, and non-hunting season uses (20), this land is very valuable to southern Michigan recreationists. A recent study indicated the national farm real estate index increased nearly $15 per acre from 1960 to 1965 (45/9). In several central cornbelt states the per acre cost index rose over 8%. For example, in Indiana it rose 12% in a four-month period from November 1965 to March 1966. The estimated cost per acre of recreation lands associated with water is $1,460 in the Lake states. All of these figures point out the necessity of obtaining needed lands now. One of the greatest problems is failing to acquire needed lands promptly following authorization.

An additional 1,400 acres of scarce waterfowl habitat is projected for acquisition in the Basin by 1980 (40). This land will cost about $90 per acre including incidental acquisition costs, which results in an amortized initial cost of about $4,100 for the total Basin acreage. This land is purchased primarily for the waterfowl, not the hunter; but it still is expected to support about 1,000 hunter-days use annually. The 900 waterfowl hunter-days use attributed to 1,500 acres of secondary waterfowl habitat will involve only incidental wildlife costs. These waters (farm ponds, fishing lakes, and park lakes) will generally be developed for purposes other than waterfowl.

We estimate that nearly 12,600 acres of Basin recreation area and park lands will be purchased by 1980. These lands could support approximately 13,000 annual hunter days. Costs of these lands would be incidental to wildlife interests, just as some costs of outdoor recreation use of State game areas fall upon the Game Division.

The cost of each man-day of hunting created in the Basin prior to 1980 on State operated lands, associated with Federally-owned reservoirs, will depend upon the facilities created and the intensity of game management.

Various options are available if those wildlife developments proposed and projected in Section V are not realized prior to 1980: 1) Hunting pressure could be increased on private lands projected to be open to hunting by 1980, if wildlife resources could stand the additional hunting pressure. This option would satisfy demand at no cost to resource agencies. 2) Various proposed sites in Basin subareas could be developed at costs comparable to those previously described. 3) Additional lands could be opened to public hunting under the Williamston Plan or the U.S. Department of Agriculture Cropland Adjustment Program. These programs are of minimal cost to the State Conservation Department. 4) Liberalization of various State hunting regulations could also provide additional man-days of opportunity at little or no cost to the managing agency.

The total cost of supplying Basin hunting demands by 1980 will depend upon the methods chosen by the Michigan Department of Conservation as being best suited for supplying opportunity to present and future hunters. An estimate of annual amortized costs might total a minimum of approximately $144,000 for the Basin's wildlife program developed by 1980 if it were to meet expected demands. Portions of this amount would be cost-shared with resource-oriented Federal agencies.

23. FINANCING FUTURE PROGRAMS

Tourism, the third largest industry in Michigan (46/44), is an important segment of the State's economy. With the recent growth of leisure-time activities, fish and wildlife and other forms of outdoor recreation will continue to contribute additional monies to the economy if sufficient quality opportunity is provided.

The Department of Conservation's ten-year program is ambitious, but well conceived and justifiable. In their plan (29/29), they state:

> "Decisions as to plans will arise, to a large extent, through determinations for meeting the deficiency in financing. Responsibility for these decisions rests with the people, the Executive Office, and the Legislature. The decisions must be shaped in the full light of over-all State budgets, resources, and fiscal policy. In making these decisions, recreation and wise use of resources must be accorded their appropriate places on a level commensurate with the major responsibilities of the State."

The worth of recreation to Michigan's future has been well established in their report. They have also clearly defined the funding deficiencies

which exist between their projected total program and anticipated financing at present appropriation levels. At present appropriation levels, only 26% of the projected ten-year fisheries program and 32% of the wildlife program could be funded (29/29).

Present fish and wildlife financing methods are generally an obligation of the user. This is a logical method, which places the burden of funding developments on those who would enjoy them.

The major means for raising fish and wildlife revenues is through license sales. In fiscal year 1964, the State received nearly $7.5 million in this manner (47/15). Federal grants used for fish and wildlife projects totaled $1.4 million in this same period. Miscellaneous revenue added an additional $0.7 million, bringing the total game and fish receipts for F.Y. 1964 to $9.6 million. The Anadromous Fish Act of 1965 is expected to contribute $7.0 million toward the State's ten-year plan. The Land and Water Conservation Act of 1965 has provided enabling funds in the amount of $16.0 million to Michigan's ten-year plan. Of this total, $2.5 million has been allocated to fish and game (29/29). Other Federal monies will be used to enhance fish and wildlife resources, but will not be directed specifically to that purpose.

The Michigan Department of Conservation has suggested means of increasing revenues in areas which presently charge nominal fees (29/29). They propose increases for hunting and fishing license fees, although they state that hunters and fishermen have paid more than their share of the total conservation program. They suggest raising fishing licenses $2, deer licenses $2.50, and small game licenses $1. For example, a resident license to hunt deer would be $7.50, and this would appear to be a very reasonable fee. Of this $2.50 increase, approximately $1 might be used for land acquisition and development and the remaining $1.50 for operation and maintenance expenses on established developments.

The Department also points out that 3% of the gasoline sold is actually used in boats, yet only ½% of the gasoline tax revenues are allotted to boating (29/29). By raising the gas tax revenues allotted to boating from ½% to 3%, the problem of financing needed public water access facilities could be remedied.

Using present revenue methods and the Conservation Department's proposed appropriation methods, the ten-year fisheries program would be deficient by 66% and the wildlife program would be 36% insolvent in meeting projected costs. The Department states (29/29): "Ways of meeting the remaining deficiency . . . . and the consideration of alternatives to the increases here suggested are appropriate matters for public discussion, debate, and decision."

There are several additional means of increasing revenues or decreasing costs for providing fish and wildlife opportunity. Fishing license requirements could be broadened to include all adults who take part in the sport. The Department's Director in 1960 suggested that any adult fishing in the Great Lakes or connecting waters should buy a fishing license, as should wives of licensed anglers (46/45). While firm estimates of the number of individuals fishing in the Great Lakes are not known, this requirement should provide sizeable increases in fish and game revenues. It was estimated that 18 percent of interviewed Basin anglers from 1958-1962 were women. Assuming this figure is correct and assuming that fishing licenses will cost $4, Michigan would gain approximately $600,000 annually by requiring fishing licenses for women, based on 1960 resident license sales. The revenue gained by requiring licenses on the Great Lakes or connecting waters should equal this figure, since men and women and residents and non-residents would be affected. It is realized that license exemptions are traditional and as such constitute a rather inflexible barrier to change--biological, social, and financial benefits notwithstanding. The Director of the Michigan Department of Conservation also requested in 1960 (46/45), "that the State do away with its antiquated bounty system, so the annual $255,000 tied up in this pointless project could be turned to useful purposes". There is still a bounty system which drains financial support from soundly based Department programs.

As multi-purpose Federal reservoir projects are constructed in Michigan in future years, fish and game facilities may be provided at less cost to the State. Many measures have been established to allow cost-sharing and long-term repayment plans for the State's share at these projects. In addition to cost-sharing features of the Federal Water Development Program, there are also indirect means of providing fishing and hunting opportunities with little or no cost to the State resource agency. These methods have been discussed in the previous cost sub-section.

Should these additional means of increasing revenues or decreasing costs not be adequate for financing future fish and wildlife developments, there is always the possibility of a State bonding program. This method is presently being considered by State officials. In recent years, other states have provided bonding programs to support outdoor recreation activities: Pennsylvania - $70 million; New York - $100 million; California - $150 million; New Jersey - $60 million; and Ohio, $55 million.

SECTION VII

BASINWIDE SUMMARY

24. GENERAL

The Grand River Basin Study was authorized by a resolution of the Committee on Public Works of the United States House of Representatives, adopted Aubust 16, 1950. The original scope of the Basin survey was redefined as a Type II Study (Comprehensive Detailed Plans) in November 1962. The basic objective in the formulation of a Type II comprehensive basin plan is to define and evaluate those projects which will be required to meet future demands, so as to permit their necessary construction in the next 10 to 15 years.

The Grand River Basin has a drainage area of about 5,600 square miles, which ranks it as the second largest river basin in Michigan. The Basin study area comprises an 11-county area which covers approximately 6,800 square miles.

The 1960 census credited the Grand River Basin study area with slightly under 1.1 million inhabitants. About half of these people resided in the Grand Rapids, Lansing, and Jackson metropolitan areas. The Basin's population increase is exceeding the percentage increase of the State and the Nation. Population is projected to total 1.5 million by 1980, 2.1 million by 2000, and 2.9 million pecple by 2020.

25. PRESENT STATUS OF FISH AND WILDLIFE RESOURCES

Basin fishing habitat is provided by 4,600 miles of fishable streams and 50,000 acres of ponded water. There are 240 miles of trout streams, located primarily in the western Grand Rapids and West Central Belt Subareas, with lesser amounts in the southeastern Jackson Subarea. Smallmouth bass and walleye streams are located in all Basin subareas and total 430 stream miles. The remaining 3,900 fishable stream miles are inhabited by species important, but less desirable, to sport fishermen. Approximately 280 miles of these streams are subjected to pollution from industrial, municipal, and agricultural sources which inhibits or periodically eliminates the game fish population and promotes a higher ratio of pollution-tolerant, non-game species. The Basin's ponded water is 70% natural lakes, 16% natural lakes with level controls, 13% impoundments, and 1% excavated lakes or farm ponds. These waters are nearly exclusively warmwater fisheries, consisting primarily of panfish, largemouth bass, walleye, perch, and related species. Each county making up the Lansing and Northeast Fringe Subareas, contrasted with all Michigan counties, ranks in the lower 15 percent in regard to the comparative acres of ponded water per county.

Analysis of angler travel patterns across Basin boundaries showed that 28% of all Michigan anglers reside in the Grand River Basin, but only 21% of all resident and non-resident angler use in Michigan occurred within the Basin. Not all Basin subareas had a net loss of angler use. The Jackson Subarea had substantially greater amounts of angler use than was generated by Subarea residents. In the West Central Belt Subarea egress was nearly equal to ingress, but in all other Basin subareas, egress was approximately twice as great as ingress. Those subareas that had the greater drawing power had greater amounts of fishing opportunity and/or lower population densities.

Approximately 140,000 residents of the Grand River Basin bought fishing licenses in 1960; and an additional 64,000 Basin residents fished, but were not required to buy licenses. However, because of Basin ingress-egress travel patterns, only about 147,000 anglers, fishing 1,517,000 days, used Basin resources in 1960.

Approximately $13\frac{1}{2}$% of all Basin anglers fished for trout; the State average was $14\frac{1}{2}$%. Of the total trout fishing effort, 75 percent has been expended on Michigan streams during the past ten years. During this same period, 85-90 percent of warmwater angling efforts were devoted to ponded waters. In 1960, Basin streams averaged 72 angler-days use per mile, including 54 days use per mile on warmwater streams and 175 days use per mile on trout streams. Ponded water received an average annual use of 24 angler days per acre. Angler success throughout the State, measured in fish per hour, averaged 2.2 in the Great Lakes, 1.2 in inland non-trout waters, and 0.7 in trout waters for the period 1953 through 1962.

At the present time, commercial fisheries landings in the Grand River Basin is limited to the fishing ports of Holland and Grand Haven on Lake Michigan. In 1964, some 27 fishermen landed 219,000 pounds of fish valued at $40,500. The primary species landed were yellow perch, chubs, and whitefish.

Of nearly 4.1 million acres of potential hunting habitat available in the Basin study area in 1960, 83% was designated as farm-game habitat, 16% was forest-game habitat, and 1% was waterfowl habitat. These lands annually support an average 0.36 hunter-days use per acre, consisting of 0.30 days use per acre on private lands (96% of total huntable lands) and 1.33 days use per acre on the remaining public hunting lands. Waterfowl habitat received an annual estimated use of 0.62 days per acre.

Approximately 85% of Michigan's population lives in the southern one-third of the State, while 96% of the public lands lie in the northern two-thirds. The Michigan Department of Conservation had acquired 87,000 acres of public hunting lands at 17 Grand River Basin sites by 1965. These areas are managed by improving the land through habitat manipulation,

which is a form of extensive wildlife management. Hunting success was nearly 50% greater on public lands than private lands; however, the harvest was 70% rabbits and squirrels and 12% pheasants on public lands and 40% pheasants on private lands. State hunting areas are heavily utilized by non-hunter outdoor recreationists, while U.S. forest lands and State park lands in the Basin provide significant public hunting opportunity.

The Williamston Plan and the Federal Cropland Adjustment Program both furnish public hunting opportunities on private lands. During the 1966-67 hunting season, over 200,000 acres of southern Michigan private lands were opened to the hunter under these programs. Privately owned acreages, open to the public on a user-fee basis, provided additional opportunities for Basin hunters.

In the southern one-third of the State, ring-necked pheasants were hunted by 87% of the total hunters, cottontail rabbits --67%, squirrels --49%, ruffed grouse --24%, ducks --16%, woodcock --12%, snowshoe "rabbits" --9%, geese --9%, and raccoon --8%. Despite more pheasant than cottontail rabbit hunters, greater numbers of hunter-days use were exerted against the cottontail.

Deer received the greatest hunter-days use of any species on a Statewide basis. The southern Michigan deer herd presently is increasing at a net rate of 14 percent annually and is expected to approach 80,000 to 90,000 head by 1968.

Rabbits and squirrels rank first and second, respectively, as huntable small game mammals in every Basin subarea. Rabbit production throughout the Basin is directly associated with the less intensively used lowland agricultural areas. In Montcalm, Jackson and Barry Counties, the average annual rabbit harvest is about 5 per hunter. Snowshoe "rabbits" are associated with mixed conifers and hardwoods. These areas occur primarily in portions of Kent and Montcalm Counties. Gray squirrels are common in the Basin's larger hardwood-forested areas, while fox squirrels are abundant in and around farm woodlots and other areas comprising a mixture of timber and open lands.

The ring-necked pheasant is the major game bird in nearly all Basin counties; harvest is especially high in portions of Ottawa, Ingham, Kent, and Shiawassee Counties. Shortages of winter and nesting cover, caused by more intensive farming practices, are having a significant effect on pheasant populations. The ruffed grouse is the second most abundant Basin game bird, and surpasses the pheasant in the hunter's bag in several counties. The range of huntable populations of bobwhite quail is limited to southeastern Michigan; Eaton, Jackson and Ingham Counties are the only Basin counties having an open season.

Migratory game birds are important to the Basin hunter. Mallards, black ducks, and blue-winged teal comprise three-fourths of the breeding ducks in southern Michigan. Major Basin concentration sites having high value for waterfowl production occur in southern and western Barry County and the majority of Jackson County. The Grand, Flat, Maple, Looking Glass, and the Upper Bad and Shiawassee Rivers all harbor concentrations of waterfowl. Ottawa, Kent, and Jackson Counties have the highest kill figures, reflecting fall population densities and hunting opportunities. Nearly 10,000 woodcock were taken annually throughout the Basin during the early 1960's; highest populations were in the western and northeastern Basin counties. The mourning dove, another migratory game bird, is not legal game in Michigan although birds are plentiful throughout the Basin and could readily support a hunting season. Dove populations had reached an estimated 775,000 birds by 1960, which is more than double the estimated population of 1953.

Analysis of hunter travel patterns across Basin boundaries indicated that about 84 percent of the hunting demand generated by Basin residents actually occurs within the Basin. The West Central Belt Subarea was the only region which had substantially greater amounts of hunter use than was generated by Subarea residents. Small game hunter ingress into the Basin slightly exceeded egress to other basins; conversely, Basin districts contributed about 40% of the total Michigan deer hunter use, but supplied only 12% of the total deer hunting pressure.

Over 145,000 licensed hunters resided within the Basin in 1960, and an additional 30,000 Basin residents hunted, but did not buy licenses. However, because of Basin ingress-egress travel patterns the pressure on Basin resources was estimated at 1,459,000 days by 147,000 hunters.

Relict systems of unique plants and animals are numerous throughout the Grand River Basin. A listing of unique natural areas, interested conservation organizations, and criteria for preserving areas are treated in this report. Resource planners must consider these remaining ecological areas in the Basin plan if this study is to be truly comprehensive.

26. FUTURE DEMANDS FOR FISH AND WILDLIFE RESOURCES

Projected license sales are considered as the best indicator of future sport fishing and hunting demands. Present license sales (participants) in the Grand River Basin are closely related to the population density and the acres of fishing and hunting opportunity in each of the subareas. License sale projections, therefore, were based on these two factors. Projected licensed participants were adjusted for unlicensed demand, latent demand, and ingress-egress travel patterns which also considered nonresident demand.

Projected angler and hunter annual participation in the Grand River Basin correlated with available habitat, but only hunter participation was also related to the population density of each subarea. Annual projected participation rates multiplied by projected participants provided instantaneous demand estimates for the target years 1980, 2000, and 2020.

Future gross demand for sport fishing is estimated to increase 32% by 1980, 75% by 2000, and 120% by 2020, over the 1960 actual Basin use. Projected gross hunting demand is projected to decrease 4% by 1980, increase 23% by 2000, and ultimately increase 56% when compared with the 1960 actual Basin use.

With reservoir construction and other fishing development programs which were completed prior to 1965, along with those planned or programmed for the period 1965-1980, it is estimated that the 1980 sport fisheries habitat will be capable of supporting approximately 97,000 additional angler-days use. However, this newly created Basin opportunity will be insufficient to meet 1980 demands by 386,000 angler days. Net demands are expected to increase to 1,130,400 angler days by 2000 and 1,824,500 by 2020.

If all of the planned or programmed near-future hunting developments are realities by the year 1980, opportunity will be created to support an additional 38,000 hunter-days use. However, projected changes in land use and availability by 1980 will reduce the capabilities of the remaining land base by 37,000 hunter-day use, leaving the Basin hunter with nearly the same amount of opportunity in 1980 as was present in 1960. An additional 67,000 hunter days will be lost due to land use changes from 1980 to 2000, plus 85,000 hunter days in the following two decades. Although net demands for additional hunting opportunities are not projected for 1980, needs will soon appear in the interim 1980 to 2000. By 2000, net hunter demands are expected to be 444,000 user days, then increase to 1,007,800 hunter-days by 2020.

27. PLANS FOR MEETING FUTURE NET DEMANDS FOR HUNTING AND FISHING

Hunting and fishing opportunity throughout the Basin can be provided by increasing the utilization of existing resources and by developing new sources of opportunity. Increased utilization of existing resources may be accomplished by improving water quality (curbing all forms of pollution); by preventing degradation of resources through unwarranted dredging, filling, and other land development practices; by providing or acquiring public access to some 6,300 acres of quality fishing waters in the Basin; by opening additional hunting lands to public use through purchase, lease, or easement; by continued progressive management programs based on sound biological principles supplied by research; by providing equitable zoning of use on available waters; by relaxing restrictive hunting regulations such as Sunday hunting closures and the ban on hunting mourning doves; and by proper water resource planning

to avoid possible loss of fish and wildlife resources through ill-advised construction programs.

New Basin hunting and fishing opportunities may be developed or created by the introduction of promising species, such as striped bass, and several species of salmon, and by constructing various types and sizes of impoundments and developing the associated project lands to meet hunting and fishing demand.

Plans have been detailed for each of the five Basin subareas. Each subarea plan lists acreage and expected usage of projected fish and wildlife developments expected prior to 1980. The magnitude of those remaining needs (net demands) for each subarea, assuming that projected developments are realized, can be met by various proposed planning options detailed in the subarea plans. Subarea planning maps are provided to locate selected sites. Preliminary use estimates on projected Basin fishery developments are expected to provide about 97,000 angler days, with a remainder of 386,000 days of fishing opportunity needed to be satisfied through construction of reservoir sites proposed for development in the total Basin plan; or through improving the capability of existing resources to sustain additional demands. The total cost of this combined program for supplying nearly 500,000 angler-days use by 1980 will depend upon management and construction programs selected by the Michigan Department of Conservation. If Basin fishing demands are to be satisfied by 1980, it is estimated that the annual amortized costs could total $480,000. Portions of this amount could and most certainly would be cost-shared with resource-oriented Federal agencies.

The hunting opportunity proposed or projected at developments within the Basin by 1980 should satisfy about 38,000 hunter-days use. Much of this opportunity will be gained in routine acquisition of State game, recreation, and park lands, with additional gains possible in conjunction with water development projects proposed in this report. The program for supplying near-future Basin hunting opportunities will also depend upon which management and construction programs might be selected. An estimate of annual amortized costs for this program might total a minimum of approximately $144,000, with portions cost-shared with Federal agencies.

These programs will be partially financed by existing revenue sources, which include hunting and fishing license sales, Federal grants, and miscellaneous licenses, fees, and resources associated elements of the tax structure. The 1965 Anadromous Fish Act, the Land and Water Conservation Act, and the Pittman-Robertson and Dingell-Johnson Restoration Acts will provide substantial sums for funding near-future programs. Additional revenue could be provided by increasing hunting and fishing license fees (Michigan ranks 44th in the cost of a fishing license), by receiving a greater share of the existing gasoline tax, by requiring

fishing licenses of the wives of resident fishermen and of those who fish in the Great Lakes, and by eliminating the bounty system.

As multi-purpose Federal reservoir projects are constructed in the Basin, fish and wildlife facilities may be provided at less cost to the State. Several methods have been established to allow cost-sharing and long-term repayment plans for the State's share at these projects. There are also a number of methods of providing additional fishing and hunting opportunities with little or no cost to the State. These methods have been discussed in the report. Should these additional means of increasing revenues or decreasing costs not be adequate for financing future fish and wildlife developments, a State bonding program might be feasible. Bonding would provide funds now, and would hedge against expected inflation.

SECTION VIII

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SUPPLEMENT 1.

An example of appropriate calculation procedures for converting population projections into gross and net fishing demands.

Grand Rapids Subarea

Given:

1960 Subarea Population	461,906
1980 Projected Subarea Population	635,600
2000 Projected Subarea Population	900,100
2020 Projected Subarea Population	1,242,600
1960 Subarea Population Per Square Mile (X_1)	323.9
1980 Subarea Population Per Square Mile (X_1)	445.7
2000 Subarea Population Per Square Mile (X_1)	631.2
2020 Subarea Population Per Square Mile (X_1)	871.4
1960 Subarea Resident Licensed Anglers	58,104
1960 Subarea Resident Licensed Anglers Per Capita	.126
1960 Subarea Estimated Unlicensed Female Anglers	8,713
1960 Percentage Anglers From Subarea That Use The Subarea	39.7%
1960 Acres of Ponded Water and Quality Streams in Subarea	15,747
1960 Acres of Ponded Water/Capita (X_2)	.034
1960 Subarea Participation Rate	12.03
1980 Estimated Acres of Ponded Water in Subarea	18,526
1980 Acres of Ponded Water/Capita (X_2)	.029
(2000 and 2020 Acres Ponded Water/Capita assumed equal to 1980)	
2000 and 2020 Participation Rates Assumed Equal to 1980	9.87

The Licensed Resident Sport Fishermen by 1980, 2000, and 2020 were determined from following regression formula developed for study area.

$$Y = (.139 - .00006\ X_1 + .33318\ X_2)\ (\text{Adjustment Factor})$$

$$\text{Adjustment Factor} = \frac{\text{Actual Sale of Fishing Licenses - Grand Rapids Subarea-1960}}{\text{Calculated Sale of Fishing Licenses-Grand Rapids Subarea 1960, using regression formula}}$$

$$\text{Adjustment Factor} = \frac{.126}{.139 - .00006\ (323.9) + .33318\ (.034)}$$
$$= \frac{.126}{.131} = .96$$

1980

$[.139 - .00006\ (445.7) + .33318\ (.029)]\ [.96] = .117$

$(635,600)\ (.117) = 74,365$ Licensed Resident Anglers

2000

$[.139 - .00006\,(631.2) + .33318\,(.029)]\,[.96] = .107$
(900,100) (.107) = 96,311 Licensed Resident Anglers

2020

$[.139 - .00006\,(871.4) + .33318\,(.029)]\,[.96] = .092$
(1,242,600) (.092) = 114,319 Licensed Resident Anglers

The Unlicensed Female Sport Fishermen for 1980, 2000, and 2020:
(All Anglers in Michigan except Females and Males under 17 Must Have Licenses)

1960

$\frac{8713}{58104} = 15.0\%$

1980
74,365 x .150 = 11,155 Unlicensed Female Anglers

2000
96,311 x .150 = 14,447 Unlicensed Female Anglers

2020
114,319 x .150 = 17,148 Unlicensed Female Anglers

The Unlicensed Anglers Under 17 years of Age for 1960, 1980, 2000, and 2020:

1960
(58,104 + 8,713) x .258 = 17,239 Unlicensed Sub-adult Anglers

1980
(74,365 + 11,155) x .258 = 22,064 Unlicensed Sub-adult Anglers

2000
(96,311 + 14,447) x .258 = 28,576 Unlicensed Sub-adult Anglers

2020
(114,319 + 17,148) x .258 = 33,918 Unlicensed Sub-adult Anglers

Latent Demand for 1980, 2000, and 2020:
(Latent Demand Factor determined at 2.6% of total population)

1980
635,600 x .026 = 16,526 Potential Anglers

2000
900,100 x .026 = 23,403 Potential Anglers

2020
1,242,600 x .026 = 32,308 Potential Anglers

The Total Number of Sport Fishermen From the Subarea in 1960, 1980, 2000, and 2020:

<u>1960</u>

58,104 + 8,713 + 17,239 = 84,506 Actual Anglers From the Subarea

<u>1980</u>

74,365 + 11,155 + 22,064 + 16,526 = 124,110 Potential Anglers From the Subarea

<u>2000</u>

96,311 + 14,447 + 28,576 + 23,403 = 162,737 Potential Anglers From the Subarea

<u>2020</u>

114,319 + 17,148 + 33,918 + 32,308 = 197,693 Potential Anglers From the Subarea

The Total Number of Sport Fishermen Using the Subarea in 1960, 1980, 2000, and 2020:

<u>1960</u>

84,056 x .397 = 33,370 Actual Anglers Using the Subarea

<u>1980</u>

124,110 x .397 = 49,272 Potential Anglers Using the Subarea

<u>2000</u>

162,737 x .397 = Potential Anglers Using the Subarea

<u>2020</u>

197,693 x .397 = 78,484 Potential Anglers Using the Subarea

Gross Demand for Sport Fishing in 1980, 2000, and 2020 (Participants x Participation) based on following participation regression formula developed for study area.

$$\text{Adjustment Factor} = \frac{\text{1960 Participation Rate (actual)}}{\text{1960 calculated participation rate using regression formula}}$$

$$\text{Participation} = [1.73 + 23.93\ X]\ [\text{Adjustment Factor}]$$

<u>1960</u>

$$\text{Adjustment Factor} = \frac{12.03}{1.73 + 23.93\ (.472)} = \frac{12.03}{13.02} = .92$$

1980

$\left[1.73 + 23.93\ (.376)\right] = 9.87$ Angler Days per Year
49,272 x 9.87 = 486,315 Gross Demand Within the Subarea

2000

64,607 x 9.87 = 637,671 Gross Demand Within the Subarea

2020

78,484 x 9.87 = 774,637 Gross Demand Within the Subarea

Net Demand for Sport Fishing in 1980, 2000, and 2020:

1980

Net Demand = 1980 Gross Demand - 1960 Actual Use
486,315 - 401,374 = 84,941 Net Demand Within the Subarea

2000

Net Demand = 2000 Gross Demand - 1980 Gross Demand + 1980 Net Demand
637,671 - 486,315 + 84, 941 = 236,297 Net Demand Within the Subarea

2020

Net Demand = 2020 Gross Demand - 2000 Gross Demand + 2000 Net Demand
774,637 - 637,671 + 236,297 = 373,297 Net Demand Within the Subarea

TABLE 1. A SUMMARY OF FISHERY USE AND RESOURCE INFORMATION - GRAND RIVER BASIN, 1960

County by Subarea	1 Quality Stream Miles	2 Other Stream Miles	3 Ponded Water Acres 1000's	4 Acres Habitat Per Capita	5 Resident Licensed Anglers 1000's	6 Anglers From Basin 1000's	7 Anglers Using Basin 1000's	8 Use/ Stream Mile	9 Use/ Ponded Water Acre
Grand Rapids									
Ottawa	12	307	6.8	.07	12.9	20.2		59	19
Kent	180	772	8.0	.02	45.2	63.8		77	22
Subarea	192	1079	14.8	.03	58.1	84.0	33.4	72	21
West Central Belt									
Montcalm	87	477	7.2	.21	9.0	13.2		73	21
Ionia	70	464	1.8	.05	7.0	10.7		70	19
Barry	70	272	11.5	.38	8.3	12.1		79	27
Subarea	227	1213	20.5	.20	24.3	36.0	37.4	73	25
Lansing									
Clinton	80	319	0.8	.03	4.3	6.1		78	19
Eaton	33	207	0.7	.02	7.3	10.6		71	23
Ingham	30	234	0.9	.01	18.7	26.6		68	23
Subarea	143	760	2.4	.01	30.3	43.3	24.9	73	22
Northeast Fringe									
Gratiot	25	241	1.4	.04	4.3	6.3		65	19
Shiawassee	20	307	0.9	.02	5.6	8.9		61	19
Subarea	45	548	2.3	.03	9.9	15.2	10.5	63	19
Jackson									
Jackson	60	324	9.8	.08	16.2	24.3	40.7	73	29
Basin Total	667	3924	49.8		138.8	202.8	146.9		
Basin Mean				.05				72	24

TABLE 2. PERCENTAGE SPECIES COMPOSITION - GRAND RIVER BASIN SPORT FISHERY CATCH, 1958-1962 1/

	Grand Rapids 2/	West Central Belt 2/	Lansing 2/	Northeast Fringe 2/	Jackson 2/	Basin 3/
Bluegill	63.2	67.4	79.6	48.5	63.9	66.0
Crappie	16.3	7.7	4.2	4.3	2.5	9.4
Perch	6.3	11.1	7.0	1.2	10.8	8.9
Sunfish	3.1	4.2	5.8	5.6	12.2	4.7
Largemouth Bass	0.9	2.9	0.4	1.2	3.5	2.1
Rock Bass	0.3	1.6	0.5	22.8	1.3	2.0
Sucker	3.6	0.5	1.0	1.4	T	1.5
Brook Trout	1.9	1.1	0.1	1.9	1.5	1.3
Rainbow Trout	1.0	1.3	T	0	2.7	1.2
Pike	0.6	1.0	1.0	6.9	0.2	1.0
Catfish	1.8	T	0.1	0.1	T	0.6
Smallmouth Bass	0.6	0.5	T	2.1	0.1	0.5
Brown Trout	0.4	0.3	T	0	0.6	0.3
Bullhead	T 4/	0.2	T	3.3	T	0.2
Carp	T	T	0.2	0.4	0.6	0.1
Walleye	T	0.1	T	0.2	T	0.1
Other 5/	T	0.1	0.1	0.1	T	0.1

1/ Michigan Department of Conservation Creel Census, 1958-1962
2/ Indicates percentage of that species caught in the particular subarea.
3/ Indicates percentage of that species caught in the entire Basin.
4/ "T" indicates less than 0.1 percent.
5/ Includes bowfin, chub, gar, sheephead, and warmouth.

TABLE 3. ESTIMATED AVERAGE ANNUAL HARVEST OF MAJOR GAME SPECIES, 1959 to 1963 - GRAND RIVER BASIN

County By Subarea	1 Deer	2 Squirrels	3 Grouse	4 Rabbits	5 Pheasant	6 Raccoon	7 Mink	8 Muskrat	9 Waterfowl	10 Woodcock
Grand Rapids										
Ottawa	103	14700	800	30100	43600	2310	150	10400	4290	1000
Kent	276	27500	3320	49400	26000	3110	150	6100	4620	1490
Subarea	379	42200	4120	79500	69600	5420	300	16500	8910	2490
West Central Belt										
Montcalm	351	13500	7920	18500	5300	1250	280	5200	3630	1610
Ionia	231	11500	4090	13800	5600	4110	140	4600	1760	360
Barry	472	16600	1790	21000	3500	2140	100	2600	3180	1790
Subarea	1054	41600	13800	53300	14400	7500	520	12400	8570	3760
Lansing										
Clinton	138	12600	--	16000	13500	11000	60	3900	1610	190
Eaton	194	15000	--	12200	14000	5060	90	2400	800	280
Ingham	101	13900	1430	23500	26400	5170	90	4600	1120	360
Subarea	433	41500	1430	51700	53900	21230	240	10900	3530	830
Northeast Fringe										
Gratiot	173	7600	1950	6800	10900	4340	100	5500	1600	2010
Shiawassee	100	8000	750	17400	24700	1430	90	2700	1310	630
Subarea	273	15600	2700	24200	35600	5770	190	8200	2910	2640
Jackson										
Jackson	249	26400	900	51800	13500	7180	170	5400	4320	270
Basin Total	2388	167300	22950	260500	187000	47100	1420	53400	28240	9990

TABLE 4. A SUMMARY OF GAME USE AND RESOURCE INFORMATION - GRAND RIVER BASIN, 1960

County By Subarea	1 Waterfowl Habitat Acres 1000's	2 Public Huntable Acres 1000's	3 Private Huntable Acres 1000's	4 Total Huntable Acres 1000's	5 Acres Habitat Per Capita	6 Resident Licensed Hunters 1000's	7 Hunters From Basin 1000's	8 Hunters Using Basin 1000's	9 Use Per Huntable Acre
Grand Rapids									
Ottawa	10.6	3.6	329.5	333.1	3.4	14.3	17.2		.33
Kent	13.3	21.3	451.7	473.0	1.3	40.5	48.6		.36
Subarea	23.9	24.9	781.2	806.1	1.8	54.8	65.8	45.0	.35
West Central Belt									
Montcalm	14.9	16.9	429.3	446.2	12.5	8.3	10.0		.36
Ionia	12.7	7.9	343.5	351.4	8.2	6.7	8.1		.34
Barry	15.4	22.6	311.6	334.2	10.5	5.8	6.9		.40
Subarea	43.0	47.4	1084.4	1131.8	10.2	20.8	25.0	34.5	.37
Lansing									
Clinton	14.8	22.3	327.7	350.0	9.2	6.3	7.6		.39
Eaton	13.7	1.0	341.7	342.7	6.9	8.5	10.2		.33
Ingham	15.2	11.6	307.3	318.9	1.5	23.9	28.7		.37
Subarea	43.7	34.9	976.7	1011.6	3.4	38.7	46.5	37.8	.36
Northeast Fringe									
Gratiot	15.7	14.3	336.7	351.0	9.5	7.5	9.0		.36
Shiawassee	14.5	7.9	318.2	326.1	6.1	9.2	11.1		.35
Subarea	30.2	22.2	654.9	677.1	7.5	16.7	20.1	16.3	.36
Jackson									
Jackson	23.2	19.3	386.3	405.6	3.1	14.1	16.9	13.1	.38
Basin Total	164.0	148.7	3883.5	4032.2		145.1	174.3	146.7	
Basin Mean					3.7				.36

TABLE 5. A SUMMARY OF UNIQUE AREAS WITHIN OR BORDERING GRAND RIVER BASIN

Site or Feature	Location	Remarks
Haehmle Audubon Bird Sanctuary	Jackson Co., T2R1, Sec. 2 and 3	Value for waterfowl and/or nesting sites for greater sandhill cranes.
Baker Audubon Bird Sanctuary	Calhoun Co., T1R6, Sec. 10, 11, and 14	Value for waterfowl and as nesting sites for greater sandhill cranes, instructional day camp.
Pitchfork Valley Wildfowl Trust	Barry Co., T1R9, Sec. 14,15,22, and 23	Has multiple unique plant and animal communities.
Waterloo Recreation Area	Jackson Co.	Has multiple unique plant and animal communities, valuable instructional area.
Yankee Springs Recreation Area	Barry Co.	Excellent plant communities within and bordering area, valuable instructional area.
Newaygo Dry Prairie	Montcalm and northwestern adjoining counties	Unique plant ecosystem.
River Bottom Flats	Portions of Maple, Looking Glass, and Grand Rivers	Excellent areas for marsh birds, ducks and other waterfowl.
Grand River Bottom Fauna	Between Muir and Comstock Park, Kent and Ionia Counties	Vestiges of unique bottom fauna, including freshwater mussels.
Indian Creek	Eaton and Calhoun Counties	Instructional area used by Olivet College; among others.

TABLE 5. (Cont.)

Site or Feature	Location	Remarks
Basswood (Linden)	Livingston Co., west of Plainfield	Largest basswood in the Nation.
Catalpa (western or northern)	Ingham, State Capitol grounds at Lansing	Largest western or northern catalpa in the Nation.
Catalpa (southern)	Kent County, Sparta	Largest southern catalpa in the Nation.
American Chestnut	Muskegon Co., Bailey	Largest American chestnut in the Nation.
Rock Elm	Eaton Co., north of Vermontville	Largest rock elm in the Nation.
White Elm	Genesee Co., Gaines	Largest white elm in the State.
Hackberry	Allegan Co., Wayland	Largest hackberry in the Nation.
Pignut Hickory	Ingham Co., west of Stockbridge	Largest pignut hickory in the State.
Michigan Winterberry Holly	Washtenaw Co., north of Chelsea	Largest Michigan winterberry holly tree in the Nation.
Shingle Oak	Eaton Co., Charlotte	Largest shingle oak in the State.
Hop Tree	Kent Co., Ada	Largest hop tree in the Nation.
Black Locust	Jackson Co., Spring-port	Largest black locust in the State.
Jack's Oak	Shiawassee Co., west of Durand	Largest Jack's oak in the Nation

TABLE 6. A SUMMARY OF STATE-OWNED PUBLIC HUNTING AREAS, WITHIN THE GRAND RIVER BASIN, 1965, LISTING PRESENT AND GOAL ACREAGES

Location	Name of Area	Present Acreage	Goal Acreage
Grand Rapids Subarea			
Ottawa Co.	Grand Haven	675	3930
Kent Co.	Cannonsburg	1327	3294
Kent Co.	Rogue River	5180	8176
Subarea Total		7182	15400
West Central Belt Subarea			
Montcalm Co.	Flat River	8949	15417
Montcalm Co.	Stanton	3305	6853
Montcalm Co.	Langston	2705	5500
Montcalm Co.	Edmore	1661	4240
Ionia Co.	Portland	1499	5275
Ionia Co.	Lowell	1850	4126
Barry Co.	Barry	14199	26011
Barry Co.	Middleville	2890	8030
Subarea Total		37058	75452
Lansing Subarea			
Clinton Co.	Rose Lake	3204	4760
Clinton Co.	Maple River	4842	11104
Ingham Co.	Dansville	4050	4931
Subarea Total		12096	20795
Northeast Fringe Subarea			
Gratiot Co.	Gratiot - Saginaw	12629	20070
Subarea Total		12629	20070
Jackson Subarea			
Jackson Co.	Sharonville	2251	5583
Jackson Co.	Waterloo	15612	15612 1/
Subarea Total		17863	21195
Basin Total		86828	152912

1/ A goal acreage was not available for the Waterloo Recreation Area.

TABLE 7. A SUMMARY OF WILLIAMSTON PLAN LANDS WITHIN THE GRAND RIVER BASIN, 1965

Location	Name	Acreage
Grand Rapids Subarea		
Ottawa Co.	Farmers' Game Club	2500
Kent Co.	Nelson - Spencer	11561
Kent Co.	North Courtland	3214
Subarea Total		17275
West Central Belt Subarea		
Ionia Co.	Ribhart	1800
Ionia Co.	Lyons	2305
Subarea Total		4105
Lansing Subarea		
Clinton Co.	Northwest Bath	2404
Clinton Co.	Riley - Watertown	8440
Clinton Co.	US-27 Game Club	3200
Eaton Co.	M-99 Conservation Club	1000
Ingham Co.	Northwest Aurelius	4000
Ingham Co.	Bunker Hill	3400
Subarea Total		22444
Northeast Fringe Subarea		
Shiawassee Co.	East New Haven	2260
Shiawassee Co.	New Haven Cons. Club	3500
Shiawassee Co.	New Haven #3 Hunt. Club	1200
Subarea Total		6960
Jackson Subarea		
None		0
Basin Total		50784

TABLE 8. A SUMMARY OF FEE HUNTING AREAS WITHIN THE GRAND RIVER BASIN, 1965

Location	Nearest Town	Acreage
West Central Belt Subarea		
Ionia Co.	Belding	241
Barry Co.	Delton	640
Barry Co.	Hastings	160
Subarea Total		1041
Lansing Subarea		
Clinton Co.	Elsie	150
Subarea Total		150
Northeast Fringe Subarea		
Shiawassee Co.	Laingsburg	294
Shiawassee Co.	Perry	415
Shiawassee Co.	Owosso	134
Shiawassee Co.	Corunna	98
Subarea Total		941
Basin Total		2132

TABLE 9. A SUMMARY OF PROJECTION DATA RELATIVE TO FUTURE FISHING DEMAND IN THE GRAND RIVER BASIN, 1960-2020 (ALL DATA EXPRESSED IN 1000's)

	Grand Rapids Subarea	West Central Subarea	Lansing Subarea	Northeast Fringe Subarea	Jackson Subarea	Basin Total
Population						
1960	461.9	110.6	299.0	90.4	132.0	1093.9
1980	635.6	142.8	434.8	115.6	177.0	1505.8
2000	900.1	184.0	626.6	154.2	250.7	2115.6
2020	1242.6	233.3	867.6	198.8	338.7	2881.0
Total Anglers (From Basin)						
1960	84.1	36.0	43.2	15.2	24.3	202.8
1980	124.1	47.2	73.9	22.4	37.2	304.8
2000	162.7	60.6	101.1	29.4	50.8	404.6
2020	197.7	75.8	132.6	37.2	65.6	508.9
Total Anglers (Using Basin)						
1960	33.4	37.4	24.9	10.5	40.7	146.9
1980	49.3	49.1	42.6	15.4	62.3	218.7
2000	64.6	63.0	58.4	20.2	85.1	291.3
2020	78.5	78.8	76.5	25.6	109.8	369.2
Gross Angler-Day Demand (Using Basin)						
1960	401.4	610.6	116.6	80.6	307.8	1517.0
1980	486.3	646.9	309.1	101.6	456.4	2000.3
2000	637.7	829.8	423.1	133.3	623.5	2647.4
2020	774.6	1037.9	554.8	169.1	805.0	3341.4
Net Angler-Day Demand (Using Basin)						
1980	84.9	36.3	192.5	21.0	148.6	483.3
2000	236.3	219.2	306.5	52.7	315.7	1130.4
2020	373.3	427.3	438.2	88.5	497.2	1824.5

TABLE 10. A SUMMARY OF PROJECTION DATA RELATIVE TO FUTURE HUNTING DEMAND IN THE GRAND RIVER BASIN, 1960-2020 (ALL DATA EXPRESSED IN 1000's)

	Grand Rapids Subarea	West Central Subarea	Lansing Subarea	Northeast Fringe Subarea	Jackson Subarea	Basin Total
Population						
1960	461.9	110.6	299.0	90.4	132.0	1093.9
1980	635.6	142.8	434.8	115.6	177.0	1505.8
2000	900.1	184.0	626.6	154.2	250.7	2115.6
2020	1242.6	233.3	867.6	198.8	338.7	2881.0
Total Hunters (From Basin)						
1960	65.8	25.0	46.5	20.1	16.9	174.3
1980	96.5	30.6	68.7	24.9	24.1	244.8
2000	131.3	35.7	93.7	30.1	32.7	323.5
2020	178.3	41.6	124.5	36.4	42.1	422.9
Total Hunters (Using Basin)						
1960	45.0	34.5	37.8	16.3	13.1	146.7
1980	66.0	42.2	55.9	20.3	18.6	203.0
2000	89.8	49.2	76.3	24.5	25.3	265.1
2020	122.0	57.4	101.3	29.6	32.5	342.8
Gross Hunter-Day Demand (Using Basin)						
1960	281.9	413.4	366.2	242.5	155.1	1459.1
1980	258.2	407.5	348.2	238.7	148.3	1400.9
2000	351.2	475.1	475.1	288.2	200.7	1790.3
2020	476.9	554.0	631.4	348.7	258.7	2269.7
Net Hunter-Day Demand (Using Basin)						
1980	None	None	None	None	None	None
2000	117.7	69.8	145.0	52.8	58.7	444.0
2020	281.1	154.1	327.9	118.3	126.4	1007.8

TABLE 11. A SUMMARY OF WATERFOWL IMPOUNDMENTS PROPOSED FOR DEVELOPMENT ON STATE GAME AREAS PRIOR TO 1980, GRAND RIVER BASIN, MICHIGAN

Subarea	Game Area	Location
Grand Rapids		
	Grand Haven SGA (water control structure with pumping station)	Dragline work and possible diking, no plans have been made to date.
	Rogue River SGA Spring Creek Dam	Rogue River Game Area engineering report available, 70 acres.
		SW of NE, Sec. 2, T 10 N, R 12 W
		NW of SW, Sec. 1, T 10 N, R 12 W
		NW of NW, Sec. 11, T 10 N, R 12 W
		SW of NW, Sec. 12, T 10 N, R 12 W (2 dams)
		NE of SW, Sec. 13, T 10 N, R 12 W
		NW of SE, Sec. 13, T 10 N, R 12 W
		SE of SE, Sec. 13, T 10 N, R 12 W
		NW of NW, Sec. 24, T 10 N, R 12 W
		NW of NE, Sec. 24, T 10 N, R 12 W
		SE of NE, Sec. 23, T 10 N, R 12 W
		NE of SW, Sec. 23, T 10 N, R 12 W
		NE of SW, Sec. 24, T 10 N, R 12 W
		SW of SW, Sec. 24, T 10 N, R 12 W
		SW of SE, Sec. 24, T 10 N, R 12 W (2 dams)
		NE of NE, Sec. 26, T 10 N, R 12 W
		SW of NW, Sec. 25, T 10 N, R 12 W
	Cannonsburg SGA	NE of SE, Sec. 29, SE of SW, Sec. 27, T 8 N, R 10 W
		SW of NW, Sec. 34, SE of NW, Sec. 34, T 8 N, R 10 W
		NE of SW, Sec. 33, SE of SW, Sec. 33, T 8 N, R 10 W
		NE of NW, Sec. 4, SE of NW, Sec. 4, T 7 N, R 10 W
		SE of NE, Sec. 4, T 7 N, R 10 W
West Central Belt		
	Langston SGA	NE$\frac{1}{4}$ of NW$\frac{1}{4}$, Sec. 27, T 11 N, R 8 W
		NE$\frac{1}{4}$ of NE$\frac{1}{4}$, Sec. 33, T 11 N, R 8 W
		SE$\frac{1}{4}$ of SE$\frac{1}{4}$, Sec. 28, T 11 N, R 8 W

TABLE 11. (Cont.)

Subarea	Game Area	Location
West Central Belt (cont.)		
	Flat River SGA	SW of SE, Sec. 34, SE of SE, Sec. 34, T 9 N, R 8 W
		$NE\frac{1}{4}$ of $NE\frac{1}{4}$, Sec. 2, T 8 N, R 8 W
		$NW\frac{1}{4}$ of $NE\frac{1}{4}$, Sec. 2, T 8 N, R 8 W
		NW of NW, Sec. 2, T 8 N, R 8 W
		NW of SE, Sec. 1, T 8 N, R 8 W
		SW of SE, Sec. 2, T 8 N, R 7 W
	Barry SGA	Glass Creek, no specific plans have been made, some private land involved.
		Turner Creek, Barry State Game Area, some engineering plans which should probably be re-evaluated.
	Stanton SGA Three Lake Flooding	NE of NW, Sec. 2, T 10 N, R 6 W dam and dragline work
		Colby Lake Dam, Stanton Game Area, no plans have been made.
		NW of NW, Sec. 2, NW of NW, Sec. 2 (1 dam)
		SW of NW, Sec. 2, SE of NW, Sec. 2, T 10 N, R 6 W
		NW of NW, Sec. 3, SW of NW, Sec. 3, T 10 N, R 6 W (1 dam)
		NE of SW, Sec. 2, T 10 N, R 6 W (1 dam)
		NE of SW, Sec. 4, T 10 N, R 6 W (1 dam)
		$NW\frac{1}{4}$ of $SE\frac{1}{4}$, Sec. 5, T 10 N, R 6 W (1 dam)
		$NE\frac{1}{4}$ of $SW\frac{1}{4}$, Sec. 5, T 10 N, R 6 W (1 dam)
		$SE\frac{1}{4}$ of $SW\frac{1}{4}$. Sec. 5, T 10 N, R 6 W (2 dams)
		$SW\frac{1}{4}$ of $SE\frac{1}{4}$, Sec. 5, T 10 N, R 6 W (1 dam)
		$SE\frac{1}{4}$ of $SE\frac{1}{4}$, Sec. 5, T 10 N, R 6 W (2 dams)
		NE of NW, Sec. 7, SE of NW, Sec. 7, T 10 N, R 6 W (7 dams)
		SE of NW, Sec. 9, T 10 N, R 6 W (1 dam)
		NE of NW, Sec. 13, T 10 N, R 7 W
		NW of NW, Sec. 13 (1 dam)
		NE of NW, Sec. 24, T 10 N, R 7 W (1 dam)
		NW of NW, Sec. 24, SW of NW, Sec. 24
		SE of NW, Sec. 24, T 10 N, R 7 W (3 dams)

TABLE 11. (Cont.)

Subarea	Game Area	Location
Northeast Fringe		
	Maple River SGA	Along the west side of US-27, diking and control structure needed. NE$\frac{1}{4}$ of SW$\frac{1}{4}$, Sec. 29, SE$\frac{1}{4}$ of NE$\frac{1}{4}$, Sec. 29 SW$\frac{1}{4}$ of NE$\frac{1}{4}$, Sec. 29, SE$\frac{1}{4}$ of NW$\frac{1}{4}$, Sec. 29 NE$\frac{1}{4}$ of NW$\frac{1}{4}$, Sec. 29, T 9 N, R 2 W Proposed future dike around open marsh.
Jackson		
	Portage Marsh	Waterloo Recreation Area, some private land must be acquired, this area is being studied at the present time for a PL-566 Project.

APPENDIX L

POWER

COMPREHENSIVE PLANNING STUDY

OF THE

GRAND RIVER BASIN, MICHIGAN

Prepared by
Chicago Regional Office
Bureau of Power
Federal Power Commission

January 1969

APPENDIX L

POWER

COMPREHENSIVE PLANNING STUDY
OF THE
GRAND RIVER BASIN, MICHIGAN

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INTRODUCTION

The determination of the electric power requirements and supply is an important part of any comprehensive basin study. The electric power needs are developed not only for purposes of determining the probable effect on the Basin economy and use of its natural resources, such as fuel, but also in order to develop estimates of future needs for cooling water.

Accordingly, historic and future (to the year 2020) electric power requirements in the Grand River Basin Power Region are presented in this appendix. The boundaries of the Power Region and Subareas designated are the same as those in the Economic Base Study, Appendix O.

SUMMARY

The Grand River Basin Power Region boundary approximates the hydrologic boundary of the Basin except that it follows county lines. The Power Region is subdivided into five Subareas: Grand Rapids, West Central Belt, Northeast Fringe, Lansing, and Jackson.

The population of the Region in 1960 was 1,093,972 or 12 percent of that of the State. The Region's average population density of 162 per square mile is about 20 greater than the State average.

The eleven counties of the Region contributed to the economy, through "value added by manufacturing", about 1.1 billion dollars or 13.6 percent of the State total in 1958. Manufacturing in these counties is confined chiefly to transportation equipment, machinery, fabricated metal, and furniture and fixtures.

The Power Region had 13 electric utility systems in 1965 of which 8 were municipally owned, 2 were privately owned, 2 were cooperatively owned, and 1 was State owned. Generating capacity located in the Region in 1965 totaled 734,864 kw. The Campbell generating plant, owned by Consumers Power Company, was the largest plant in the Region in 1965 with an installed capacity of 265,000 kw. Thermal generation, mostly steam, accounted for 721,939 kw or 98.2 percent of the Region's capacity.

Electric power requirements to serve the load in the Power Region in 1965 totaled about 5.93 billion kwh with an associated peak demand of about 1.09 million kw. Energy requirements generated within the Region totaled about 3.51 billion kwh with the balance, about 2.42 billion kwh, supplied by imports.

As of December 31, 1965 there were 10 hydroelectric power plants in the Power Region with a total installed capacity of 11,325 kw. These plants generate an average annual energy of about 37.1 million kwh at an average annual plant factor of 37 percent.

There are known potential hydroelectric projects in the Region totaling 18,700 kw which could produce an average of about 78.4 million kwh annually. Although these potential projects are physically feasible, economic feasibility has not yet been established.

Electric power requirements are estimated to increase to about 16.4 billion kwh with a peak demand of about 2.9 million kw by 1980 and to about 77.5 billion kwh with a peak demand of about 13.4 million kw by 2020.

The thermal electric energy supplied by generation within the Region is expected to be all fossil fueled in 1980. By 2020 it is estimated that nearly all generation in the Region will be nuclear.

Under specific assumptions outlined in this report, the cooling water required and the consumptive use sustained from steam electric condenser cooling in the Region is expected to increase from about 335,900 acre-feet per year required and about 3,835 acre-feet per year lost in 1965 to requirements of 3,396,950 acre-feet per year and losses of 36,940 acre-feet per year in 2020.

The water requirement for condenser cooling represents the amount of cooling water required to pass through condensers and is not necessarily equivalent to that diverted. The amount required equals the amount diverted only in the case of flow-through cooling; in plants utilizing cooling ponds or towers it is necessary to divert only enough water to replace the consumptive losses. The depletion of water from the supply is equal to the consumptive use which is on the order of one percent of the amount required to pass through the condenser. This depletion consists not only of the evaporative losses from cooling ponds and cooling towers, but also includes the incremental evaporative losses in rivers and natural bodies of water caused by the imposed condenser heat load at plants utilizing flow-through cooling.

The amounts given for cooling water required and the losses sustained are for the entire Power Region. It should be borne in mind that a sizable portion of the thermal capacity would be located outside the Basin drainage area, using Lake Michigan as its water source. Therefore, these plants would result in no diversion or depletion of water from the Grand River Basin.

SECTION I
DESCRIPTION OF BASIN AS RELATED TO
ELECTRIC POWER PRODUCTION AND REQUIREMENTS

1. GRAND RIVER BASIN POWER REGION

The Grand River Basin is located in the southern portion of the Lower Peninsula of Michigan. The Power Region consists of the following eleven Michigan counties: Barry, Clinton, Eaton, Gratiot, Ingham, Ionia, Jackson, Kent, Montcalm, Ottawa, and Shiawassee. Locations of high load concentration within the Power Region are influenced by major economic centers designated as, Standard Metropolitan Statistical Areas (SMSA's). There are three SMSA's within the Power Region: Grand Rapids, comprised of Kent and Ottawa Counties; Lansing, comprised of Clinton, Eaton, and Ingham Counties; and Jackson, comprised of Jackson County. These have been chosen as three of the five power subareas. The remaining two subareas are the Northeast Fringe, consisting of Gratiot and Shiawassee Counties, and the West Central Belt, consisting of Montcalm, Ionia and Barry. The Power Region and Subareas are identical with the Area and Subareas established in the Economic Base Study, Appendix O. Plate I shows the delineation of the Grand River Basin, the Power Region, and the Subarea boundaries.

2. POWER REGION ECONOMY

Population density, industrial employment, and value of farm products marketed are indicators of the electric energy requirement in an area, as well as of the economic activity of the area.

In 1960, the Grand River Basin Power Region, with a land area of 6,770 square miles, had a population of 1,093,972, accounting for about 12 percent of the State of Michigan's land area and 14 percent of its population. The Power Region's 1960 average population density of 162 persons per square mile was approximately 20 percent greater than the State average. Table 1 lists the population density within the Power Region by Subareas.

Gaged by 1960 employment by major industry groups, manufacturing ranked number one with 35 percent of the Region total employment, followed by services and trades with 22 and 19 percent, respectively. Within manufacturing, the most important areas were transportation equipment, machinery, fabricated metal, and furniture and fixtures. As a measure of the industrial output of the Region, the total "value added by manufacture" for the eleven county region was slightly more than 1.1 billion dollars in 1958 or 13.6 percent of the State total.

Agriculture accounts for about 5 percent of the Region's employment. Based on 1959 data, the eleven county area comprising the Power Region marketed farm products valued at nearly 155 million dollars or 25 percent of the total State farm product value.

A complete description of the Power Region's economy is included in Appendix O, Economic Base Study.

SECTION II
ELECTRIC POWER INDUSTRY CHARACTERISTICS

1. ORGANIZATION OF THE ELECTRIC POWER INDUSTRY

In 1965, the electric power requirements of the Grand River Basin Power Region were supplied by thirteen utilities located either partially or totally within the Region. Ownership of these systems was as follows: municipal, 8; private, 2; cooperative, 2; and State, 1. Table 2 gives a breakdown by type of ownership of the 1965 energy requirements and installed generating capacity of utilities within the Region.

Consumers Power Company, serving customers in all eleven counties of the Power Region, is the largest power supplier; it served nearly 75 percent of the 1965 total Region requirement. Lansing Board of Water and Light, which serves the Lansing metropolitan area, supplied about 20 percent of the Region's requirement. Table 3 gives a percent breakdown of 1965 energy supplied and installed generating capacity by systems, and Table 6 gives the electric power requirement by Subareas for the Power Region.

The Power Region is currently served by a 138 kv high voltage transmission network operated by Consumers Power Company. This network is supported by lower voltage transmission interconnecting the systems within the Region.

A major Extra-High-Voltage transmission system is planned for service in Lower Michigan by 1970. This system will effectively and directly interconnect Michigan with the large Central and Eastern United States interconnected groups. Intrastate, it will consist of 345 kv interconnections between Consumers Power Company, Indiana and Michigan Electric Company, and the Detroit Edison Company and many miles of EHV lines on the internal transmission systems of these utilities. Plate II gives the principal existing and future transmission facilities serving the Power Region.

2. COMPONENTS OF THE ELECTRIC POWER SUPPLY

Steam plants, using coal as fuel, currently generate the major portion of the electric energy in the Grand River Basin Power Region. There are a number of small diesel and hydroelectric plants in the Region, but these account for only a small part of the present energy supply (3.7%), and it is anticipated that they will become increasingly less significant in the future. Plates III-A and III-B show the location and size of the existing thermal electric and hydroelectric plants in the Region.

3. OPERATING PRACTICES

Operating practices of systems in the Power Region contributing to the continuing reliability of the electric power supply consist of distributed spinning reserves; provisions for load shedding in cases of extreme emergency; adequate communication between systems; and maintenance, inspection, and testing of control devices. In addition, emergency start-up power is available if a statewide or local power failure should occur.

4. COORDINATION OF THE POWER SUPPLY

Coordination varies from contractual agreements among systems located within the Power Region to supply energy requirements during emergencies to formal coordinated operation, planning, and construction of facilities with utilities outside the Region. The Michigan Pool, consisting of Consumers Power Company and the Detroit Edison Company, engages in continuous interchange of energy on an economy basis and practices joint planning of system development and operation. Consumers Power Company is a member of the Michigan-Ontario Pool and the "MIIO" Pool (Michigan-Indiana-Illinois-Ohio) and participates in planning and coordination with other members of these groups. Detroit Edison Company is also a member of these groups.

SECTION III
HYDROELECTRIC POWER

1. PRESENT STAGE OF HYDROELECTRIC DEVELOPMENT

There were 10 hydroelectric projects in the Power Region as of December 31, 1965, representing a total installed capacity of 11,325 kw. This was less than 2 percent of the Region's 1965 installed capacity. These projects produce an average of 37.1 million kwh annually at an average capacity factor of 37 percent. Table 4 lists these projects with pertinent data for each. All of these power plants are small, and the majority were constructed at least 30 years ago. It is anticipated that the older plants will be retired or possibly redeveloped as conditions warrant, principally on the basis of physical condition and high operating cost. For purposes of this study, however, and since the effect of hydroelectric generation is small, it was assumed that all existing projects would remain in use throughout the period of study.

2. REQUIREMENTS AND PROCEDURES FOR LICENSING PROJECTS

The FPC licensing authority dates back to the Federal Water Power Act of 1920, which is now Part I of the Federal Power Act. By this authority, the Commission is responsible for licensing non-Federal hydroelectric projects which affect the interest of interstate or foreign commerce, or which affect public lands and reservations of the United States.

An important conservation provision of the Federal Power Act is the requirement that a project to be licensed must, in the judgment of the Federal Power Commission, be best adapted to a comprehensive river basin plan. In addition to standard provisions requiring compliance with rules prescribed for the protection of life, health, and property, licenses may also contain special provisions in the interest of flood control, water quality control, navigation, public health, recreation, preservation of scenic beauty, or protection of fish and wildlife. The Federal Power Commission also requires each applicant for a license to file a proposed plan for full public utilization of the project waters and adjacent project lands for recreation purposes along with information showing the effect on fish and wildlife.

3. PROJECTS OPERATING UNDER FPC LICENSE

There are no projects in the Grand River Basin Power Region now operating under FPC license. There is one project, Webber, owned by Consumers Power Company, that has a license application pending (project No. 2566). This project is listed in Table 4.

4. POTENTIAL HYDROELECTRIC POWER

The natural conditions existing in the Grand River Basin Power Region do not favor extensive hydroelectric power developments. The highly developed agricultural lands, the numerous cities and towns, and costly transportation facilities within potential reservoir areas, limit the possibilities for development of storage sites.

Undeveloped hydroelectric potential in the Region is estimated to be about 18,700 kw which could produce an average of about 78.4 million kwh of energy annually. This includes four potential sites and a capacity increase at the existing Portland site. A summary of data for these sites is included in Table 5 and their locations are shown on Plate III-A.

Projects considered as potential in this report are not necessarily economically feasible to develop at this time. In order to screen these projects, they need to be investigated as to their estimated development cost, the value of the potential capacity and energy available, size of plant, transmission required, etc., when specific projects are formulated. The value of the potential hydroelectric supply is considered to be equivalent to the cost of developing and operating the most likely alternative source of supply. This would, in most instances, be a thermal electric plant of the type currently being installed.

The amount of possible future hydroelectric supply involved is small in relation to the total basin supply and would have a negligible effect on the future thermal supply required. However, for purposes of this study, all of the known potential hydroelectric power projects have been included in the future capacity supply.

SECTION IV
MARKET FOR POWER

The Grand River Basin Power Region is currently an importer of electric energy, and it is expected that the Region will continue to import in the future at about the present rate. In 1965 about 41 percent of the Region's energy requirement was imported from plants located outside the Region. By the year 2020 it is projected that this import will amount to about 44 percent. Table 8 shows the projected amounts of energy imported into the Region at intervals throughout the study period.

At the present time the bulk of the energy generated within the Power Region is located in the Grand Rapids and Lansing Subareas. It should be noted that the Campbell plant of Consumers Power Company, the largest plant in the Power Region, is located in the Grand Rapids Subarea on the shore of Lake Michigan. Although this is outside the Grand River Basin drainage area, it is within the area defined as the Power Region and therefore has not been considered as an import in this report. In addition, Consumers Power Company has stated that, because of inadequate cooling water in the Grand River Basin for the size units being contemplated, all proposed installations to serve the Basin would be located on the Great Lakes. A major portion of the supply for the Grand Rapids Subarea (about 95%) will be located outside the Basin drainage area but in the Subarea as defined in this study. Consequently, the Grand Rapids and Lansing Subareas will continue to supply a substantial portion of their own requirements. The three remaining Subareas, West Central Belt, Northeast Fringe, and Jackson, which have historically been supplied by imports, will continue to be supplied by imports in the future.

SECTION V

FUTURE ELECTRIC POWER REQUIREMENTS AND SUPPLY

1. THE POWER INDUSTRY'S PROSPECTS FOR GROWTH, 1980, 2000, AND 2020

Increased electric power load growth can naturally be expected to accompany population growth and economic expansion, but the electric utility industry has historically exceeded these growth rates. Progressively higher standards of living will also expand the future market, but the greatest incentive will come from the reduction in costs for electric energy relative to other elements in the cost of living.

In addition to its efforts to lower costs, the electric utility industry must also intensify its efforts aimed at public acceptance of its facilities. This involves a consideration of air pollution, overcoming public concern about nuclear plants in congested areas, and "beautification" features that may require underground distribution and possibly even underground transmission. Furthermore, the industry is faced with increasing costs of right-of-way in fast growing urban areas. Larger capital costs can also be expected for the provision of cooling towers where an adequate water supply is not available.

Based on past trends, current operation, and announced future plans, the existing and projected electric power requirements for the Power Region are given in Table 6. The projection of future power requirements to 1990 are based on estimates prepared by Regional Advisory Committees composed of representatives of the electric power industry in cooperation with the FPC. These estimates are part of the Federal Power Commission's current program to update the 1964 National Power Survey Report and to extend the period of study to 1990. The Region's electric requirements are estimated to increase throughout the period of study, but at a decreasing annual rate. By 2020 the growth rate is estimated to be about 3 percent per year.

2. FUTURE POWER GENERATING EQUIPMENT BY TYPES

Projections for this study extend beyond four decades into the future. Many factors that will influence future decisions, particularly with regard to nuclear generation, are yet to be resolved.

The type of generating equipment in the Power Region can have an effect on the economics of the Region, not only from the standpoint of huge investments involved, but also from the standpoint of the fuel source. In view of the recent rapid advances in the amount of nuclear fueled capacity on order, it is necessary to carefully consider this as a major component of future generating capacity.

Present thinking places the nuclear market in areas where competing fuel costs run about 20 cents per million Btu or higher. This would include the Grand River Basin Power Region. This market must be further qualified, however, to unit-size requirements exceeding 400 to 500 megawatts for investor-owned utilities and 100 megawatts for municipals. The competitive situation today is shown on Plate IV for a 600 megawatt unit with private financing and on Plate V for a 100 megawatt unit with municipal financing. A study by Kaiser Engineers for the Atomic Energy Commission indicates that nuclear power reactors in sizes as low as 50 to 100 megawatts could be competitive with municipal financing if ordered in groups of five.

Beyond 1980, and perhaps somewhat earlier, the more advanced types of reactors should be making their appearance, increasing the potential market considerably. Higher capital costs are indicated, but fuel costs have been projected to as low as 5 cents per million Btu. Estimates of nuclear fuel costs to the year 1985 are shown on Plate VI.

3. LOCATION OF THERMAL GENERATION

Water availability is a basic criterion in determining the location of thermal generating plants. Fuel can be transported to a plant and electric energy can be transmitted from plant to load center. This arrangement is flexible and an economic balance can be determined between the relative distances of fuel and electrical transportation. Water for cooling purposes, however, cannot be moved any great distance economically. The water resources of the Basin will be an important factor in the generation of electric power.

Conversion of thermal energy to electric energy on a large scale basis is very inefficient at the present time in spite of all the progress that has been made. An amount of energy, in the form of heat, greater than that which is converted to electric energy is lost in the process. The common practice has been to absorb the greater part of this loss in large bodies of water. Because of the limited streamflow within the Grand River Basin, it will become increasingly necessary to use supplemental types of cooling for those capacity additions not utilizing Lake Michigan as a cooling water source. Supplemental types of cooling such as cooling towers and ponds will be possible only at an increase in capital and operating costs.

Based on the considerations discussed and the conditions existing in the Power Region, estimates of the future power supply in the Region were derived as shown in Tables 7, 8, and 9.

SECTION VI
COOLING WATER REQUIREMENTS FOR STEAM ELECTRIC GENERATION
1960, 1965, 1980, 2000, AND 2020

1. FACTORS DETERMINING COOLING WATER REQUIREMENTS

At the present time essentially all of the electric power produced by thermal electric generation requires cooling water. Thermal electric plants requiring cooling water now comprise about 92 percent of all the electric generating capacity in the Power Region and account for about 96 percent of all the energy produced in the Region.

Predictions of the patterns of generation beyond 1980 are complicated by several factors, not the least of which is the accuracy of predicted energy requirements beyond that date. The electric power industry is one of the most dynamic industries in the United States, having experienced an annual growth rate of between 6 and 7 percent for a number of years as compared to a somewhat lesser rate for the Gross National Product. The technology of electric generation and supply is changing rapidly with the advent of larger and larger units made possible by rapid load growth, the increasing reliance on extra high voltage transmission, the construction of mine-mouth generation, utilization of unit-type coal trains, and the large increase in the number of scheduled nuclear fueled plants. Also, new methods of generating power which eliminate the conventional heat cycle and thus eliminate the need for cooling water are under active consideration. Among the most promising of these are MHD or magnetohydrodynamics, EGD or electrogasdynamics, thermionic generation, the fuel cell, etc. Firm planning for future generating capacity is not completed until shortly before (say, four to six years) the need becomes apparent. Accordingly, it is to be realized that estimates of consumptive use of cooling water in the years 2000 and 2020 can only be a rough guide to be reviewed periodically as new situations develop. A projection of future water requirements for thermal electric plants has been made on this basis. However, as is evident from subsequent discussion in this report, there are alternatives to the demands for cooling water of good quality. For example, in the event that fresh water is in short supply due to scarcity or imposition of higher priority use, brackish water or sewage effluent can be utilized under certain conditions as a cooling source for thermal electric generation. On the other hand, with considerable added expenditure, the consumptive use (primarily evaporation) can be almost entirely eliminated by the use of radiator-type closed circuit cooling towers. Also, with the advent of EHV, power can be transmitted over long distances from areas of adequate water supply to water deficient regions.

The principal demand imposed upon water supply by thermal electric generating plants is for condenser cooling water. Boiler makeup water is required for all steam electric plants and some installations also use water for sluicing ashes. These latter two uses have relatively

minor effects on the water supply and their future magnitudes have therefore not been projected.

2. CALCULATION OF COOLING WATER REQUIREMENTS

Condenser cooling water is considered in two aspects -- first, the amount of water that is required to pass through a condenser in order to produce an acceptable vaccuum; and second, the amount of cooling water that is evaporated as a result of the increase in its temperature. Either or both of these could be critical in designing and selecting the site for a power plant.

For purposes of analysis, the method used herein for determining the condenser cooling water requirement of a fossil fuel electric generating station is illustrated by the following sample calculation:

Sample Calculation

Cooling Water Requirements 1/

Operating Conditions

Assumed over-all plant efficiency		36%
Assumed generator efficiency		97.5%
Heat equivalent of one kilowatt-hour		3,413 Btu
Fuel energy required (net plant heat rate)	9,500	Btu/kwh 2/
Heat loss from boiler-furnace 3/	950	"
Energy delivered to turbine	8,550	"
Heat loss from generator 4/	94	"
Generator output (net gen. plus 7% plant use)	3,650	"
Energy removed in condenser (energy delivered to turbine minus generator output)	4,806	"
Energy to be removed by water source 5/	4,900	"

Cooling Water Required:

$$\text{Acre-feet/kwh} = \frac{\text{Energy removed by water source}}{\text{Heat Absorption Rate of Water } 6/ \times {}^{\circ}\text{F. temp. change in cooling water}}$$

$$= \frac{4{,}900 \text{ Btu/kwh}}{2{,}718{,}144 \text{ Btu/ac-ft/}{}^{\circ}\text{F. temp. change} \times \text{temp. change in cooling water}}$$

$$= \frac{0.001803 \quad 7/}{{}^{\circ}\text{F. temp. change in cooling water}}$$

1/ Cooling water required is the amount of water needed to remove

heat imposed and is independent of the type of cooling -- flow-through, pond, or tower.

2/ Average U. S. heat rate in 1966 was 10,547 Btu/kwh.
3/ Negligible for nuclear plants.
4/ Generator cooling usually part of cooling water load.
5/ Equals condenser load plus generator heat loss.
6/ 1 Btu/lb. water/^{o}F. temp. change in water; 2,718,144 lbs. water = 1 ac-ft.
7/ The quantity of cooling water required varies inversely with permitted temperature rise of cooling water.

This shows that, under the assumed conditions shown above, 4,900 Btu of heat is transferred to the cooling water for each kilowatt-hour generated. Experience has demonstrated that the most economical plant designs provide for cooling water temperature rises of 10 to 20 degrees. Based on an average rise of 18 degrees F., it follows from the sample calculation that 100.2 acre-feet of cooling water is required to pass through the condenser for each million kilowatt-hours generated.

Nuclear plants have a higher heat load to dissipate than fossil fuel plants (using current design standards) and thus require about 150 acre-feet of condenser cooling water per million kilowatt-hours assuming an 18^{o} F. temperature rise. Based on an anticipated improvement in nuclear plant operating efficiency it is estimated that the cooling water required will decrease to about 79 acre-feet per million kilowatt-hours by 2020.

3. COOLING WATER CONSUMPTIVE USE (LOSS)

The primary consumptive use of cooling water is the amount that evaporates due to the increase in its temperature as it passes through the condensing unit. The amount of evaporation will depend on the type of cooling employed: cooling pond or reservoir, wet or dry type cooling tower, or flow-through.

If the cooling water is taken from and discharged back into a pond or reservoir, the heat in the circulated water is dissipated to the atmosphere through convection or induced evaporation. The water that is evaporated is lost to the air, and so becomes a consumptive use attributable to the power operation. Evaporation provides about 64.5 percent of the cooling, in a stationary water body, under average meteorological conditions. Thus, if a power plant contributes 4,900 Btu per kilowatt-hour, about 4,900 x 0.645, or 3,160 Btu per kilowatt-hour is dissipated through evaporation. Since the evaporation of one pound of water consumes about 1,055 Btu, the consumptive use at the pond cooled power plant is 3,160 ÷ 1,055 or 3.0 pounds of water per kilowatt-hour. This amounts to 1.10 acre-feet per million kilowatt-hours generated. This figure will vary somewhat as operating conditions such as efficiency and temperature rise of the cooling water differ from those assumed.

On the other hand, if the cooling water is diverted from a flowing stream and discharged back into the stream after passing through the condensing unit, the evaporation loss is probably somewhat less than for a cooling pond. The water passing through the condenser in a flow-through system is not evaporated in the condenser, but as a result of the heat load transferred to the water as it passes through the condenser, evaporation takes place when it is returned to its source. For purposes of this study, it is estimated that under average conditions 54 percent of the cooling in a flow-through system is from evaporation. Based on a heat discharge of 4,900 Btu per kilowatt-hour and 54 percent evaporation, about 2,645 Btu per kilowatt-hour would be dissipated by the evaporation of 2.5 pounds of water. This amounts to approximately 0.92 acre-feet per million kilowatt-hours generated. As with cooling ponds, this figure is applicable only under the specified conditions of the sample calculations.

In systems using wet type cooling towers, evaporation accounts for about 85 percent of the cooling, and there are some additional water losses because of spray drift and blowdown loss. The total consumptive cooling tower loss averages about 1.47 acre-feet per million kilowatt-hours generated. As mentioned above, the loss will vary under operating conditions differing from those assumed in the sample calculation.

Nuclear plants currently have a higher consumptive water use than do fossil fuel plants. At the present time they require about 50 percent more than fossil fuel plants. Based on future improvement in nuclear plant operating efficiency it is anticipated that the amount of waste heat dissipated by these plants will be substantially reduced; this will result in a proportionate decrease in consumptive water use.

All of the figures shown above represent hypothetical conditions believed to be about average for the circumstances that could be encountered. Obviously, there are many variables of plant design, location, meteorological conditions, etc., that might cause the figures for cooling water required and loss for a specific plant to vary from those suggested here.

4. FUTURE COOLING WATER REQUIREMENTS AND LOSSES

In order to determine future cooling water requirements and consumptive water use in the Power Region, Table 10 which develops an allocation of electric generation by types of cooling and fuel used, was prepared. A considerable degree of freedom in the pattern which may develop is evident in this projection. However, the quantities shown are believed to represent a degree of magnitude which can reasonably be expected. Further refinement must be made as plans are developed for specific projects in the long-range future.

To depict the effect of varying the more important parameters governing cooling water requirements and losses, four families of curves were plotted. The first two sets, Plates VII and VIII, illustrate the

effect of discharge temperature change and varying heat rates on the amount of water required to pass through the condenser in both fossil fuel and nuclear plants. Plates IX and X show the relationship of plant heat rate to cooling water consumption at a given change in temperature (18 degrees) of the cooling water at fossil and nuclear fueled plants. Curves are shown for the three primary types of cooling -- flow-through, cooling pond, and wet type cooling towers. Water consumption by dry type cooling towers is very low and is considered to be negligible for purposes of this study.

As is evident from Plates VII, VIII, IX, and X, the efficiency of the generating plant affects the amount of water required and lost. For purposes of this report, the following heat rates are assumed to be representative of present and possible future values for the Power Region.

Type Plant	Net Plant Heat Rates (Btu per kilowatt-hour)				
	1960	1965	1980	2000	2020
Coal fueled	11,600-12,000	8,800-11,000	8,800-11,000	8,500	8,500
Nuclear fueled	-	-	-	8,000	7,500

The generation data of Table 10 were converted to estimate future cooling water requirement and consumptive loss for the Region based on the foregoing method and assumptions. Table 11 gives the resulting water required and consumptive losses by types of generation and cooling for the Power Region during the period of study. It should be noted, however, that the total required flow includes water which is recirculated. It is, in effect, the total amount of water that is passed through condensers and not the total amount diverted from a stream source. The water diverted will generally be less, depending on the amount of cooling ponds and towers employed.

5. GENERAL CONCLUSIONS

Under the assumptions outlined, the Grand River Basin Power Region water requirements and consumptive use are as follows:

	1960	1965	1980	2000	2020
Cooling Water Requirements (acre-feet per year)	131,800	335,900	584,700	1,739,000	3,396,950
Consumptive Use (acre-feet per year)	1,800	3,835	6,560	18,940	36,940

As indicated by the above, the consumptive use is only a small part

(about one percent) of the total water required for cooling.

Although the foregoing indicates the amount of cooling water required and the losses sustained through generation within the Power Region, several qualifying factors should be kept in mind:

a. The amount of cooling water required and losses sustained for the various periods of study are representative of the entire Power Region. It should be borne in mind that a sizable portion of the thermal capacity would be located outside the Basin drainage area, using Lake Michigan as its water source. Therefore, these plants would result in no diversion or depletion of water from the Grand River Basin.

b. The amount of cooling water required to pass through a plant's condenser is not necessarily equivalent to that diverted continuously from a stream source. This is true only in the case of flow-through cooling; in plants utilizing cooling ponds or towers it is necessary to divert only enough water to replace the consumptive losses.

c. The water diverted for cooling at generating plants is returned to the stream (except for consumptive loss) and may be reused at downstream plants or for such other purposes as municipal use, irrigation, or industrial use. If the distance between point of plant discharge and point of reuse is not far enough to allow the heat discharged to mix with the streamflow and for the stream to return to an acceptable temperature, it may be necessary to use some type of supplemental cooling to achieve this. Since the water supply may be reused, the adequacy of the supply to support an amount of generation should be determined in relation to a specific plant site.

d. Alternative means of condenser cooling are available where water supply is scarce or where the aquatic environment would be degraded. The amount of water required, temperature of the discharge, and the losses sustained can be varied at the discretion of designers by changing the design parameters. Two of the most important of these parameters are type of cooling and permissible temperature rise. The type of cooling employed has an important effect on the water consumption, being the greatest for wet type cooling towers and the lowest for dry type cooling towers. As the demand for water approaches more closely the available supply, the cost differential incurred with supplemental types of cooling may be more than offset by the relative worth of the water supply conserved.

Table 1

Grand River Basin Power Region
Population Density

Counties	Land Area (sq. miles)	1960 Population	Density (pop./sq. mile)
Kent	862	363,187	421
Ottawa	564	98,719	175
Grand Rapids Subarea 1/	1,426	461,906	324
Barry	549	31,738	58
Ionia	575	43,132	75
Montcalm	712	35,795	50
West Central Belt Subarea	1,836	110,665	60
Gratiot	566	37,012	65
Shiawassee	540	53,446	99
Northeast Fringe Subarea	1,106	90,458	82
Clinton	571	37,969	66
Eaton	567	49,684	88
Ingham	559	211,296	378
Lansing Subarea 1/	1,697	298,949	176
Jackson	705	131,994	187
Jackson Subarea 1/	705	131,994	187
Total Power Region	6,770	1,093,972	162
State of Michigan	57,019	7,823,194	137

1/ Subarea is same as Standard Metropolitan Statistical Area (SMSA)

Table 2

Grand River Basin Power Region
Composition of Power Industry
1965

	Ownership				
	Investor-owned	Municipal	Cooperatives	State	Total
Total Grand River Basin					
No. of Systems					
Generating	2	7	1	1	11
Distribution only	-	1	1	-	2
Total	2	8	2	1	13
Generating Capacity					
kw	295,360	414,977	12,527	12,000	734,864
Percent	40.2	56.5	1.7	1.6	100.0
Energy Generated					
1000 kwh	1,985,160	1,394,919	46,623	83,185	3,509,887
Percent	56.6	39.7	1.3	2.4	100.0

Table 3

Grand River Basin Power Region
Utility Energy Requirements and Generating Capacity
1965

Utility	Energy Requirement (percent of Region)	Generating Capacity (percent of Region)
Consumers Power Co.	73.3	40.1
Eaton Rapids	0.2	0.0
Grand Haven	1.3	5.3
Holland	2.3	7.3
Lansing	19.4	41.3
Lowell	0.3	0.8
Michigan State University	1.7	1.6
Mid-State Service Co.	-	0.1
Portland	0.2	0.2
St. Louis	0.1	0.5
Tri County Electric Coop.	0.7	0.0
Wolverine Electric Coop.	0.1	1.7
Zeeland	0.4	1.1
Total Region	100.0	100.0

Table 4

Grand River Basin Power Region
Existing Hydroelectric Power Plants - 1965

Project Name	River	Owner Class 1/	Owner	Drainage Area Sq. Mi.	Gross Head (ft.)	Installed Capacity (kw)	Average Ann. Energy (1000 kwh)	Avg. Flow Utilized (cfs)	Hydraulic Capacity (cfs)	Initial Operation Year
Ada	Thornapple	U	Consumers Power Co.	825	22	2,000	6,700	580	1,515	1934
Cascade	Thornapple	U	Consumers Power Co.	813	28	2,560	8,000	545	1,525	1934
La Barge 2/	Thornapple	U	Consumers Power Co.	776	19	700	3,400	340	615	1922
Lowell 2/	Flat	U	Consumers Power Co.	545	34	900	5,100	285	440	1930
Webber 4/	Grand	U	Consumers Power Co.	1,751	26	3,250	9,100	665	2,085	1907
Moores Park	Grand	P	Lansing Wtr. & Lt. Comm.	758	15	1,000	2,600	330	1,110	1907
North Lansing	Grand	P	Lansing Wtr. & Lt. Comm.	1,230	9	200	1,100	230	370	1936
Lowell	Flat	P	Lowell, Village of	545	18	630	2,700	285	585	1917
Irving	Thornapple	U	Mid-State Service Co.	NA	7	600	2,300	625	1,430	1939
Middleville	Thornapple	U	Mid-State Service Co.	NA	12	350	1,500	240	485	1939
Portland	Grand	P	Portland Electric Dept.	1,695	20	375	2,400	230	310	1930
St. Louis 3/	Pine	P	St. Louis, City of	NA	10	360	700	135	600	NA

1/ U - Privately Owned Utility
P - Non-Federal Publicly Owned

2/ Plant retired 12-27-65

3/ Plant located outside River Basin but within Power Region boundary

4/ License pending - Project No. 2566

Table 5

Grand River Basin Power Region
Possible Future Hydroelectric Developments

Project Name	River	Drainage Area (sq.mi.)	Gross Head (ft)	Installed Capacity (kw)	Avg. Annual Energy (1000 kwh)	Avg. Flow Utilized (cfs)	Hydraulic Capacity (cfs)
Grand Rapids	Grand	4,900	17	6,700	30,000	2,880	5,630
Saranac	Grand	2,980	16	3,700	16,700	1,700	3,300
Portland 1/	Grand	1,695	20	2,400	5,400	440	1,710
McGee	Grand	1,395	32	3,300	14,200	720	1,470
Danby	Grand	1,325	32	2,600	12,100	620	1,160

1/ Redevelopment of existing site

Table 6

Grand River Basin Power Region
Existing and Projected Electric Power Requirements

Subarea	Annual Energy (1000 kwh)	Annual Peak (kw)	Annual Load Factor (percent) 1/
	1960		
Grand Rapids	1,908,000	345,000	63.0
West Central Belt	255,000	55,000	52.7
Northeast Fringe	207,000	45,000	52.7
Lansing	1,235,000	240,000	58.6
Jackson	545,000	100,000	62.0
Total Region	4,150,000	785,000	60.2
	1965		
Grand Rapids	2,688,000	485,000	63.5
West Central Belt	364,000	80,000	53.4
Northeast Fringe	292,000	60,000	53.5
Lansing	1,807,000	325,000	63.0
Jackson	779,000	140,000	63.5
Total Region	5,930,000	1,090,000	62.1
	1980		
Grand Rapids	7,515,000	1,315,000	65.1
West Central Belt	1,005,000	205,000	55.5
Northeast Fringe	815,000	165,000	56.0
Lansing	4,865,000	850,000	65.0
Jackson	2,150,000	380,000	64.1
Total Region	16,350,000	2,915,000	63.9
	2000		
Grand Rapids	18,760,000	3,230,000	66.1
West Central Belt	2,510,000	490,000	58.2
Northeast Fringe	2,030,000	380,000	61.0
Lansing	12,140,000	2,090,000	66.1
Jackson	5,360,000	950,000	64.3
Total Region	40,800,000	7,140,000	65.0
	2020		
Grand Rapids	35,630,000	6,055,000	67.0
West Central Belt	4,760,000	900,000	60.2
Northeast Fringe	3,860,000	710,000	61.7
Lansing	23,060,000	3,920,000	67.0
Jackson	10,190,000	1,780,000	65.1
Total Region	77,500,000	13,365,000	66.0

1/ Load Factor - Ratio of average load over designated period to the peak load occurring in that period.

Table 7

Grand River Basin Power Region
Existing and Projected Capacity Requirements and Supply
(kilowatts)

Subarea	Annual Peak	Reserves	Total Required	Hydro Supply	Net Region Import	Thermal-Electric Supply
1960						
Grand Rapids	345,000	39,260	384,260	6,160	291,896	86,204
West Central Belt	55,000	6,177	61,177	5,370	45,117	10,690
Northeast Fringe	45,000	2,125	47,125	360	43,250	3,515
Lansing	240,000	67,930	307,930	1,200	77,230	229,500
Jackson	100,000	-	100,000	-	100,000	-
Total Region	785,000	115,492	900,492	13,090	557,493	329,909
1965						
Grand Rapids	485,000	71,164	556,164	6,160	159,770	390,234
West Central Belt	80,000	4,408	84,408	5,205 1/	65,513	13,690
Northeast Fringe	60,000	1,675	61,675	360	57,800	3,515
Lansing	325,000	95,650	420,650	1,200	104,950	314,500
Jackson	140,000	-	140,000	-	140,000	-
Total Region	1,090,000	172,897	1,262,897	12,925	528,033	721,939
1980						
Grand Rapids	1,315,000	96,800	1,411,800	12,000	611,600	788,200
West Central Belt	205,000	2,000	207,000	16,600	190,400	-
Northeast Fringe	165,000	-	165,000	400	164,600	-
Lansing	850,000	57,000	907,000	1,200	443,000	462,800
Jackson	380,000	-	380,000	-	380,000	-
Total Region	2,915,000	155,800	3,070,800	30,200	1,789,600	1,251,000
2000						
Grand Rapids	3,230,000	306,800	3,536,800	12,000	870,000	2,654,800
West Central Belt	490,000	1,900	491,900	16,600	475,300	-
Northeast Fringe	380,000	-	380,000	400	379,600	-
Lansing	2,090,000	135,800	2,225,800	1,200	1,045,600	1,179,000
Jackson	950,000	-	950,000	-	950,000	-
Total Region	7,140,000	444,500	7,584,500	30,200	3,720,500	3,833,800

1/ Includes 1,600 kilowatts retired 12/27/65

Table 7

Grand River Basin Power Region
Existing and Projected Capacity Requirements and Supply
(kilowatts)

Subarea	Annual Peak	Reserves	Total Required	Hydro Supply	Net Region Import	Thermal-Electric Supply
			2020			
Grand Rapids	6,055,000	611,000	6,666,000	12,000	965,000	5,689,000
West Central Belt	900,000	1,800	901,800	16,600	885,200	-
Northeast Fringe	710,000	-	710,000	400	709,600	-
Lansing	3,920,000	270,000	4,190,000	1,200	1,668,000	2,520,800
Jackson	1,780,000	-	1,780,000	-	1,780,000	-
Total Region	13,365,000	882,800	14,247,800	30,200	6,007,800	8,209,800

Table 8

Grand River Basin Power Region
Existing and Projected Energy Requirements and Supply
(1000 kwh)

Subarea	Total Energy Required	Hydro Production 1/	Net Region Import	Thermal-Electric Production
		1960		
Grand Rapids	1,908,000	24,560	1,684,547	198,893
West Central Belt	255,000	21,960	201,264	31,776
Northeast Fringe	207,000	1,035	199,492	6,473
Lansing	1,235,000	3,356	396,411	835,233
Jackson	545,000	-	545,000	-
Total Region	4,150,000	50,911	3,026,714	1,072,375
		1965		
Grand Rapids	2,688,000	18,613	466,748	2,202,639
West Central Belt	364,000	16,245	301,066	46,689
Northeast Fringe	292,000	699	283,401	7,900
Lansing	1,807,000	1,005	589,898	1,216,097
Jackson	779,000	-	779,000	-
Total Region	5,930,000	36,562	2,420,113	3,473,325
		1980		
Grand Rapids	7,515,000	47,400	3,496,000	3,971,600
West Central Belt	1,005,000	63,700	941,300	-
Northeast Fringe	815,000	700	814,300	-
Lansing	4,865,000	3,700	2,529,000	2,332,300
Jackson	2,150,000	-	2,150,000	-
Total Region	16,350,000	115,500	9,930,600	6,303,900
		2000		
Grand Rapids	18,760,000	47,400	5,060,000	13,652,600
West Central Belt	2,510,000	63,700	2,446,300	-
Northeast Fringe	2,030,000	700	2,029,300	-
Lansing	12,140,000	3,700	6,068,000	6,068,300
Jackson	5,360,000	-	5,360,000	-
Total Region	40,800,000	115,500	20,963,600	19,720,900
		2020		
Grand Rapids	35,630,000	47,400	5,680,000	29,902,600
West Central Belt	4,760,000	63,700	4,696,300	-
Northeast Fringe	3,860,000	700	3,859,300	-
Lansing	23,060,000	3,700	9,796,000	13,260,300
Jackson	10,190,000	-	10,190,000	-
Total Region	77,500,000	115,500	34,221,600	43,162,900

1/ Based on average annual energy for years 1980, 2000, and 2020.

Table 9

Grand River Basin Power Region
Composition of the Thermal-Electric Power Supply

	Non-Condensing Type 1/			Condensing Type					
	Internal Combustion			Nuclear			Fossil Fuel		
	Energy Produced (1000 kwh)	Capacity Factor (%) 2/	Capacity (kw)	Energy Produced (1000 kwh)	Capacity Factor (%) 2/	Capacity (kw)	Energy Produced (1000 kwh)	Capacity Factor (%) 2/	Capacity (kw)
1960									
Grand Rapids	93,503	35.2	30,204	-	-	-	105,390	21.4	56,000
West Central Belt	31,776	33.8	10,690	-	-	-	-	-	-
Northeast Fringe	6,473	21.0	3,515	-	-	-	-	-	-
Lansing	-	-	-	-	-	-	835,233	41.4	229,500
Jackson	-	-	-	-	-	-	-	-	-
Total Region	131,752	33.8	44,409	-	-	-	940,623	37.5	285,500
1965									
Grand Rapids	38,694	13.9	31,734	-	-	-	2,163,945	68.9	358,500
West Central Belt	46,689	38.9	13,690	-	-	-	-	-	-
Northeast Fringe	7,900	25.6	3,515	-	-	-	-	-	-
Lansing	-	-	-	-	-	-	1,216,097	44.1	314,500
Jackson	-	-	-	-	-	-	-	-	-
Total Region	93,283	21.8	48,939	-	-	-	3,380,042	57.3	673,000
1980									
Grand Rapids	negligible	-	-	-	-	-	3,971,600	57.4	788,200
West Central Belt	"	-	-	-	-	-	-	-	-
Northeast Fringe	"	-	-	-	-	-	-	-	-
Lansing	"	-	-	-	-	-	2,332,300	57.4	462,800
Jackson	"	-	-	-	-	-	-	-	-
Total Region	"	-	-	-	-	-	6,303,900	57.4	1,251,000

1/ Requires no condenser cooling water.

2/ Capacity Factor - Ratio of average output to maximum capacity.

Table 9

Grand River Basin Power Region
Composition of the Thermal-Electric Power Supply

	Non-Condensing Type 1/			Condensing Type					
	Internal Combustion			Nuclear			Fossil Fuel		
	Energy Produced (1000 kwh)	Capacity Factor (%) 2/	Capacity (kw)	Energy Produced (1000 kwh)	Capacity Factor (%) 2/	Capacity (kw)	Energy Produced (1000 kwh)	Capacity Factor (%) 2/	Capacity (kw)
2000									
Grand Rapids	negligible	-	-	11,650,000	80.0	1,657,300	2,002,600	22.8	997,500
West Central Belt	"	-	-	-	-	-	-	-	-
Northeast Fringe	"	-	-	-	-	-	-	-	-
Lansing	"	-	-	6,068,300	66.2	1,043,200	-	-	135,800
Jackson	"	-	-	-	-	-	-	-	-
Total Region	"	-	-	17,718,300	74.7	2,700,500	2,002,600	20.1	1,133,300
2020									
Grand Rapids	negligible	-	-	29,894,600	61.4	5,546,000	8,000	6.4	143,000
West Central Belt	"	-	-	-	-	-	-	-	-
Northeast Fringe	"	-	-	-	-	-	-	-	-
Lansing	"	-	-	13,260,300	59.9	2,520,800	-	-	-
Jackson	"	-	-	-	-	-	-	-	-
Total Region	"	-	-	43,154,900	60.9	8,066,800	8,000	6.4	143,000

1/ Requires no condenser cooling water

2/ Capacity Factor - Ratio of average output to maximum capacity.

Table 10

Grand River Basin Power Region
Annual Generation Requiring Condenser Cooling - By Types
(1000 kwh)

Subarea	Type Generation	Wet Tower	Cooling Pond	Flow-Through	Subarea Total
		Type Cooling			
		1960			
Grand Rapids	Fossil Fuel	-	-	105,390	105,390
	Nuclear	-	-	-	-
	Total	-	-	105,390	105,390
West Central Belt	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Northeast Fringe	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Lansing	Fossil Fuel	771,873	-	63,360	835,233
	Nuclear	-	-	-	-
	Total	771,873	-	63,360	835,233
Jackson	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Total Region	Fossil Fuel	771,873	-	168,750	940,623
	Nuclear	-	-	-	-
	Total	771,873	-	168,750	940,623

Table 10

Grand River Basin Power Region
Annual Generation Requiring Condenser Cooling - By Types
(1000 kwh)

Subarea	Type Generation	Type Cooling: Wet Tower	Type Cooling: Cooling Pond	Type Cooling: Flow-Through	Subarea Total
		1965			
Grand Rapids	Fossil Fuel	-	-	2,163,945	2,163,945
	Nuclear	-	-	-	-
	Total	-	-	2,163,945	2,163,945
West Central Belt	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Northeast Fringe	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Lansing	Fossil Fuel	1,132,912	-	83,185	1,216,097
	Nuclear	-	-	-	-
	Total	1,132,912	-	83,185	1,216,097
Jackson	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Total Region	Fossil Fuel	1,132,912	-	2,247,130	3,380,042
	Nuclear	-	-	-	-
	Total	1,132,912	-	2,247,130	3,380,042

Table 10

Grand River Basin Power Region
Annual Generation Requiring Condenser Cooling - By Types
(1000 kwh)

Subarea	Type Generation	Wet Tower	Cooling Pond	Flow-Through	Subarea Total
		---Type Cooling---			
		1980			
Grand Rapids	Fossil Fuel	-	-	3,971,600	3,971,600
	Nuclear	-	-	-	-
	Total	-	-	3,971,600	3,971,600
West Central Belt	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Northeast Fringe	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Lansing	Fossil Fuel	2,175,300	-	157,000	2,332,300
	Nuclear	-	-	-	-
	Total	2,175,300	-	157,000	2,332,300
Jackson	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Total Region	Fossil Fuel	2,175,300	-	4,128,600	6,303,900
	Nuclear	-	-	-	-
	Total	2,175,300	-	4,128,600	6,303,900

Table 10

Grand River Basin Power Region
Annual Generation Requiring Condenser Cooling - By Types
(1000 kwh)

Subarea	Type Generation	Wet Tower	Cooling Pond	Flow-Through	Subarea Total
		---------------Type Cooling---			
		2000			
Grand Rapids	Fossil Fuel	-	-	2,002,600	2,002,600
	Nuclear	-	-	11,650,000	11,650,000
	Total	-	-	13,652,600	13,652,600
West Central Belt	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Northeast Fringe	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Lansing	Fossil Fuel	-	-	-	-
	Nuclear	6,068,300	-	-	6,068,300
	Total	6,068,300	-	-	6,068,300
Jackson	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Total Region	Fossil Fuel	-	-	2,002,600	2,002,600
	Nuclear	6,068,300	-	11,650,000	17,718,300
	Total	6,068,300	-	13,652,600	19,720,900

Table 10

Grand River Basin Power Region
Annual Generation Requiring Condenser Cooling - By Types
(1000 kwh)

Subarea	Type Generation	Wet Tower	Cooling Pond	Flow-Through	Subarea Total
		Type Cooling			
		2020			
Grand Rapids	Fossil Fuel	-	-	8,000	8,000
	Nuclear	-	-	29,894,600	29,894,600
	Total	-	-	29,902,600	29,902,600
West Central Belt	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Northeast Fringe	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Lansing	Fossil Fuel	-	-	-	-
	Nuclear	13,260,300	-	-	13,260,300
	Total	13,260,300	-	-	13,260,300
Jackson	Fossil Fuel	-	-	-	-
	Nuclear	-	-	-	-
	Total	-	-	-	-
Total Region	Fossil Fuel	-	-	8,000	8,000
	Nuclear	13,260,300	-	29,894,600	43,154,900
	Total	13,260,300	-	29,902,600	43,162,900

Table 11

Grand River Basin Power Region
Annual Cooling Water Requirements and Losses
(acre-feet)

Subarea	Type Generation	Total Required to Pass Through Condenser	Water Losses by Types of Cooling: Wet Tower	Cooling Pond	Flow-Through	Subarea Total
		1960				
Grand Rapids	Fossil Fuel	15,400	-	-	141	141
	Nuclear	-	-	-	-	-
	Total	15,400	-	-	141	141
West Central Belt	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Northeast Fringe	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Lansing	Fossil Fuel	116,400	1,574	-	85	1,659
	Nuclear	-	-	-	-	-
	Total	116,400	1,574	-	85	1,659
Jackson	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Total Region	Fossil Fuel	131,800	1,574	-	226	1,800
	Nuclear	-	-	-	-	-
	Total	131,800	1,574	-	226	1,800

Table 11

Grand River Basin Power Region
Annual Cooling Water Requirements and Losses
(acre-feet)

Subarea	Type Generation	Total Required to Pass Through Condenser	Water Losses by Types of Cooling: Wet Tower	Cooling Pond	Flow-Through	Subarea Total
		1965				
Grand Rapids	Fossil Fuel	188,900	-	-	1,734	1,734
	Nuclear	-	-	-	-	-
	Total	188,900	-	-	1,734	1,734
West Central Belt	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Northeast Fringe	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Lansing	Fossil Fuel	147,000	2,004	-	97	2,101
	Nuclear	-	-	-	-	-
	Total	147,000	2,004	-	97	2,101
Jackson	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Total Region	Fossil Fuel	335,900	2,004	-	1,831	3,835
	Nuclear	-	-	-	-	-
	Total	335,900	2,004	-	1,831	3,835

Table 11

Grand River Basin Power Region
Annual Cooling Water Requirements and Losses
(acre-feet)

Subarea	Type Generation	Total Required to Pass Through Condenser	Water Losses by Types of Cooling: Wet Tower	Cooling Pond	Flow-Through	Subarea Total
		1980				
Grand Rapids	Fossil Fuel	346,700	-	-	3,180	3,180
	Nuclear	-	-	-	-	-
	Total	346,700	-	-	3,180	3,180
West Central Belt	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Northeast Fringe	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Lansing	Fossil Fuel	238,000	3,200	-	180	3,380
	Nuclear	-	-	-	-	-
	Total	238,000	3,200	-	180	3,380
Jackson	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Total Region	Fossil Fuel	584,700	3,200	-	3,360	6,560
	Nuclear	-	-	-	-	-
	Total	584,700	3,200	-	3,360	6,560

Table 11

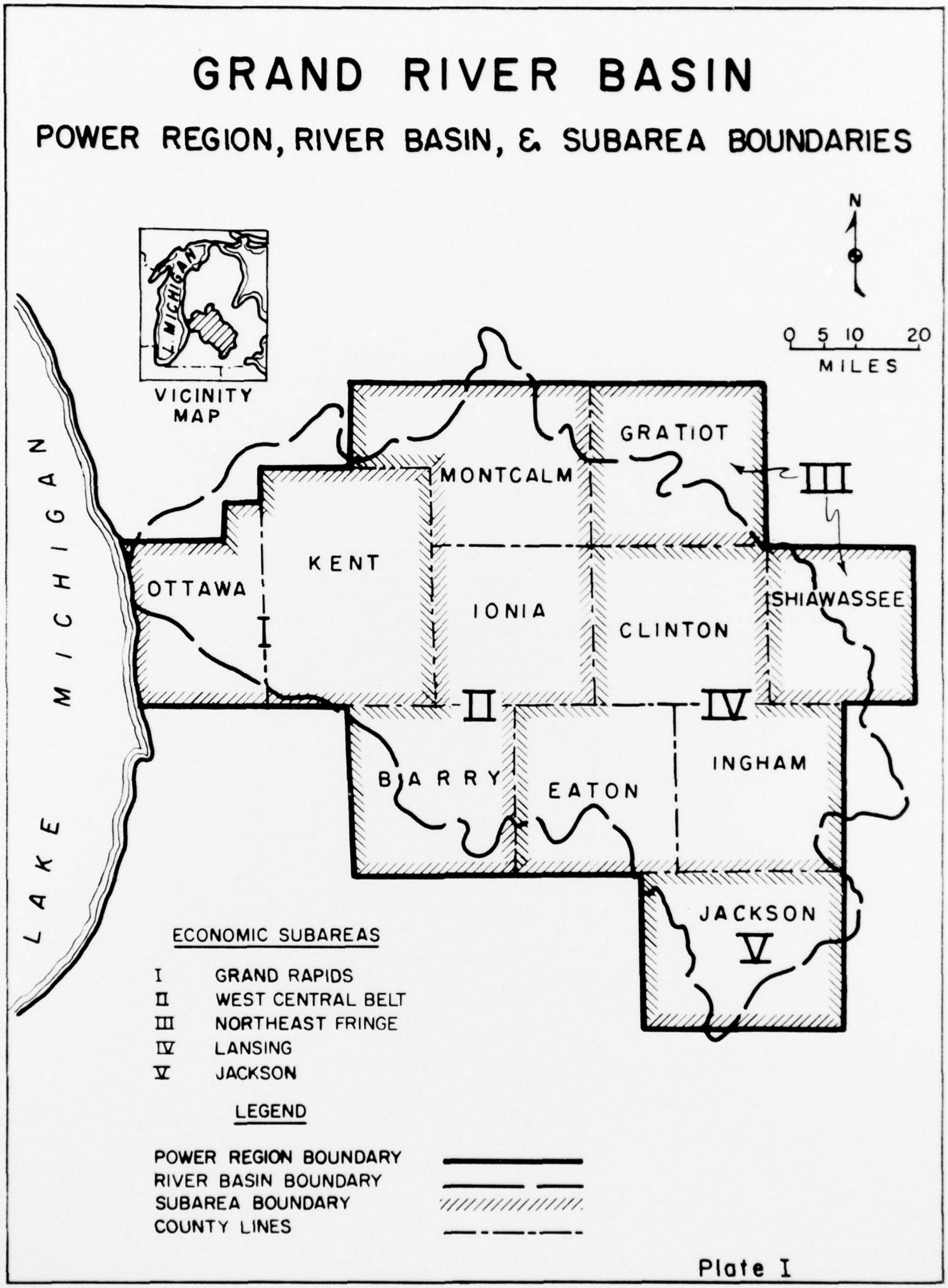
Grand River Basin Power Region
Annual Cooling Water Requirements and Losses
(acre-feet)

Subarea	Type Generation	Total Required to Pass Through Condenser	Water Losses by Types of Cooling: Wet Tower	Cooling Pond	Flow-Through	Subarea Total
		2000				
Grand Rapids	Fossil Fuel	163,800	-	-	1,500	1,500
	Nuclear	1,035,700	-	-	9,510	9,510
	Total	1,199,500	-	-	11,010	11,010
West Central Belt	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Northeast Fringe	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Lansing	Fossil Fuel	-	-	-	-	-
	Nuclear	539,500	7,930	-	-	7,930
	Total	539,500	7,930	-	-	7,930
Jackson	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Total Region	Fossil Fuel	163,800	-	-	1,500	1,500
	Nuclear	1,575,200	7,930	-	9,510	17,440
	Total	1,739,000	7,930	-	11,010	18,940

Table 11

Grand River Basin Power Region
Annual Cooling Water Requirements and Losses
(acre-feet)

Subarea	Type Generation	Total Required to Pass Through Condenser	Water Losses by Types of Cooling: Wet Tower	Cooling Pond	Flow-Through	Subarea Total
		2020				
Grand Rapids	Fossil Fuel	650	-	-	10	10
	Nuclear	2,352,700	-	-	21,600	21,600
	Total	2,353,350	-	-	21,610	21,610
West Central Belt	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Northeast Fringe	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Lansing	Fossil Fuel	-	-	-	-	-
	Nuclear	1,043,600	15,330	-	-	15,330
	Total	1,043,600	15,330	-	-	15,330
Jackson	Fossil Fuel	-	-	-	-	-
	Nuclear	-	-	-	-	-
	Total	-	-	-	-	-
Total Region	Fossil Fuel	650	-	-	10	10
	Nuclear	3,396,300	15,330	-	21,600	36,930
	Total	3,396,950	15,330	-	21,610	36,940


GRAND RIVER BASIN
POWER REGION, RIVER BASIN, & SUBAREA BOUNDARIES
N
0 5 10 20
MILES
L. MICHIGAN
VICINITY MAP
LAKE MICHIGAN
OTTAWA
KENT
MONTCALM
GRATIOT
IONIA
CLINTON
SHIAWASSEE
BARRY
EATON
INGHAM
JACKSON
I
II
III
IV
V
ECONOMIC SUBAREAS
I GRAND RAPIDS
II WEST CENTRAL BELT
III NORTHEAST FRINGE
IV LANSING
V JACKSON
LEGEND
POWER REGION BOUNDARY
RIVER BASIN BOUNDARY
SUBAREA BOUNDARY
COUNTY LINES
Plate I

GRAND RIVER BASIN

PRINCIPAL TRANSMISSION FACILITIES

-1965-

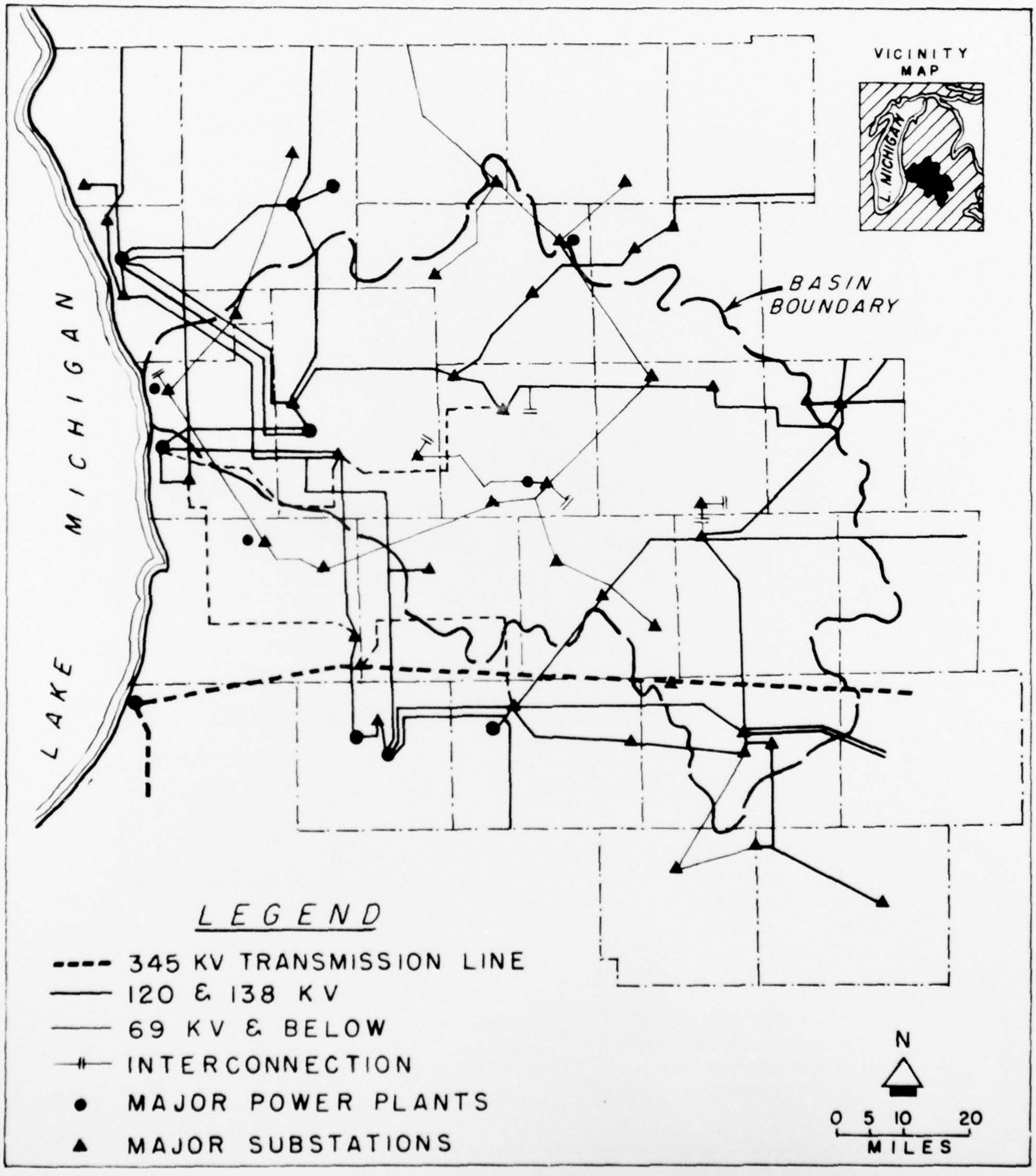
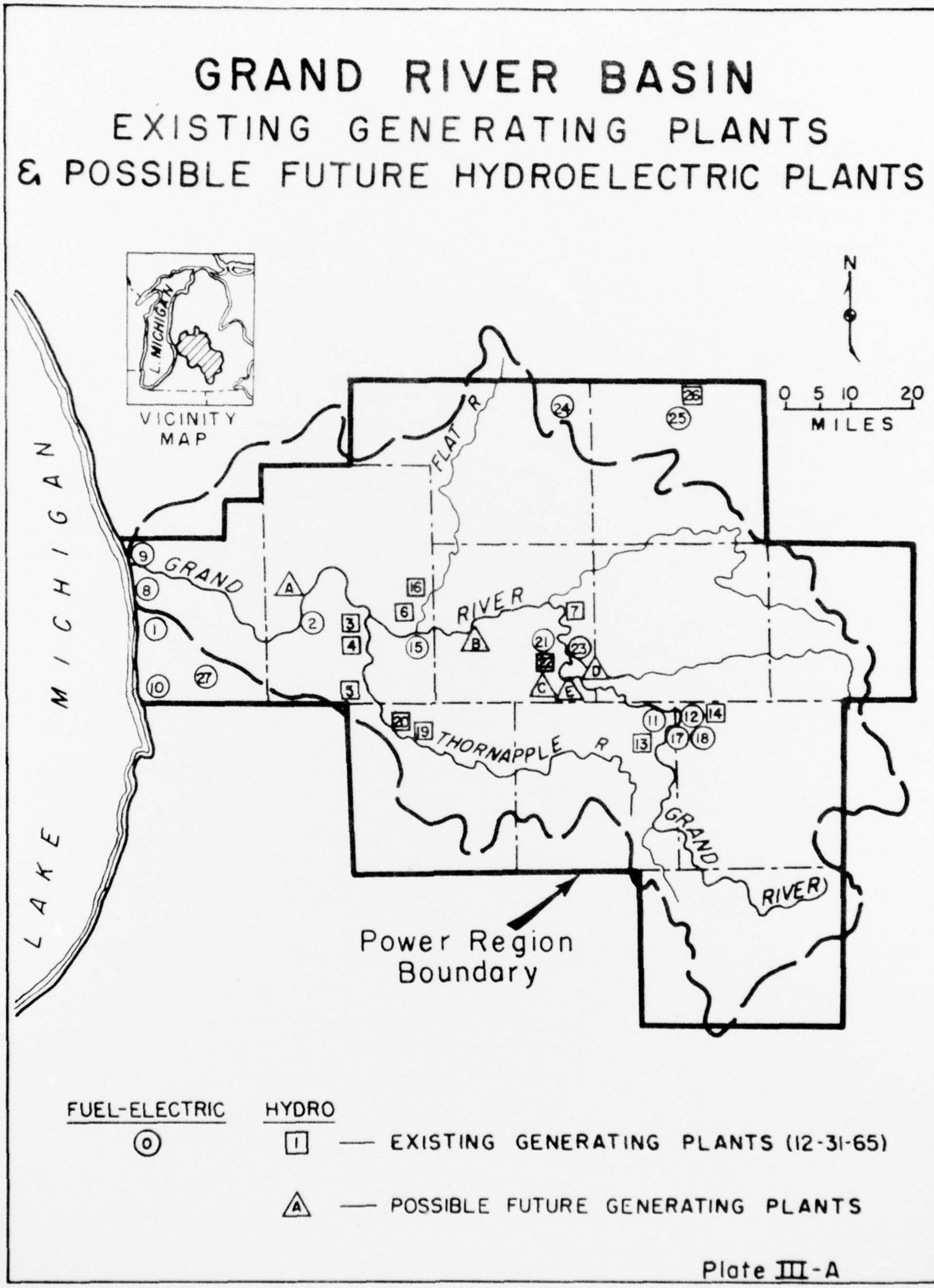


Plate II


GRAND RIVER BASIN
EXISTING GENERATING PLANTS
& POSSIBLE FUTURE HYDROELECTRIC PLANTS
VICINITY MAP
L. MICHIGAN
N
0 5 10 20
MILES
LAKE MICHIGAN
GRAND
RIVER
FLAT R
THORNAPPLE R
GRAND
RIVER
Power Region Boundary
FUEL-ELECTRIC
HYDRO
— EXISTING GENERATING PLANTS (12-31-65)
— POSSIBLE FUTURE GENERATING PLANTS
Plate III-A

Plant List

Grand River Basin Power Region
Existing Fuel-Electric and Hydroelectric Plants
and Possible Future Hydroelectric Plants

Map No. & Name of Plant		Installed Capacity (kw)	Type	Owner
	Existing Fuel-Electric and Hydroelectric Plants - 1965			
1	Campbell, J. H.	265,000 2/	St.	Consumers Power Company
2	Wealthy St.	20,000	St.	Consumers Power Company
3	Ada	2,000	Hy.	Consumers Power Company
4	Cascade	2,560	Hy.	Consumers Power Company
5	La Barge 1/	700	Hy.	Consumers Power Company
6	Lowell 1/	900	Hy.	Consumers Power Company
7	Webber	3,250	Hy.	Consumers Power Company
8	Grand Haven	20,000	St.	Grand Haven
9	Grand Haven	18,630	I.C.	Grand Haven
10	DeYoung, James	53,500	St.	Holland
11	Moores Park	221,000	St.	Lansing
12	Ottawa St.	81,500	St.	Lansing
13	Moores Park	1,000	Hy.	Lansing
14	North Lansing	200	Hy.	Lansing
15	Lowell	4,936	I.C.	Lowell
16	Lowell	630	Hy.	Lowell
17	North Campus	6,000	St.	Mich. State University
18	Shaw Lane	6,000	St.	Mich. State University
19	Irving	600	Hy.	Mid-State Service Co.
20	Middleville	350	Hy.	Mid-State Service Co.
21	Jenkins, F. L.	1,163	I.C.	Portland
22	Portland	375	Hy.	Portland
23	Winder, C. A.	4,086	I.C.	Wolverine Electric Coop.
24	Vestaburg	8,441	I.C.	Wolverine Electric Coop.
25	St. Louis	3,515	I.C.	Saint Louis
26	St. Louis	360	Hy.	Saint Louis
27	Zeeland	8,168	I.C.	Zeeland
	Possible Future Hydroelectric Plants			
A	Grand Rapids	6,700	Hy.	-
B	Saranac	3,700	Hy.	-
C	Portland	2,400	Hy.	-
D	McGee	3,300	Hy.	-
E	Danby	2,600	Hy.	-

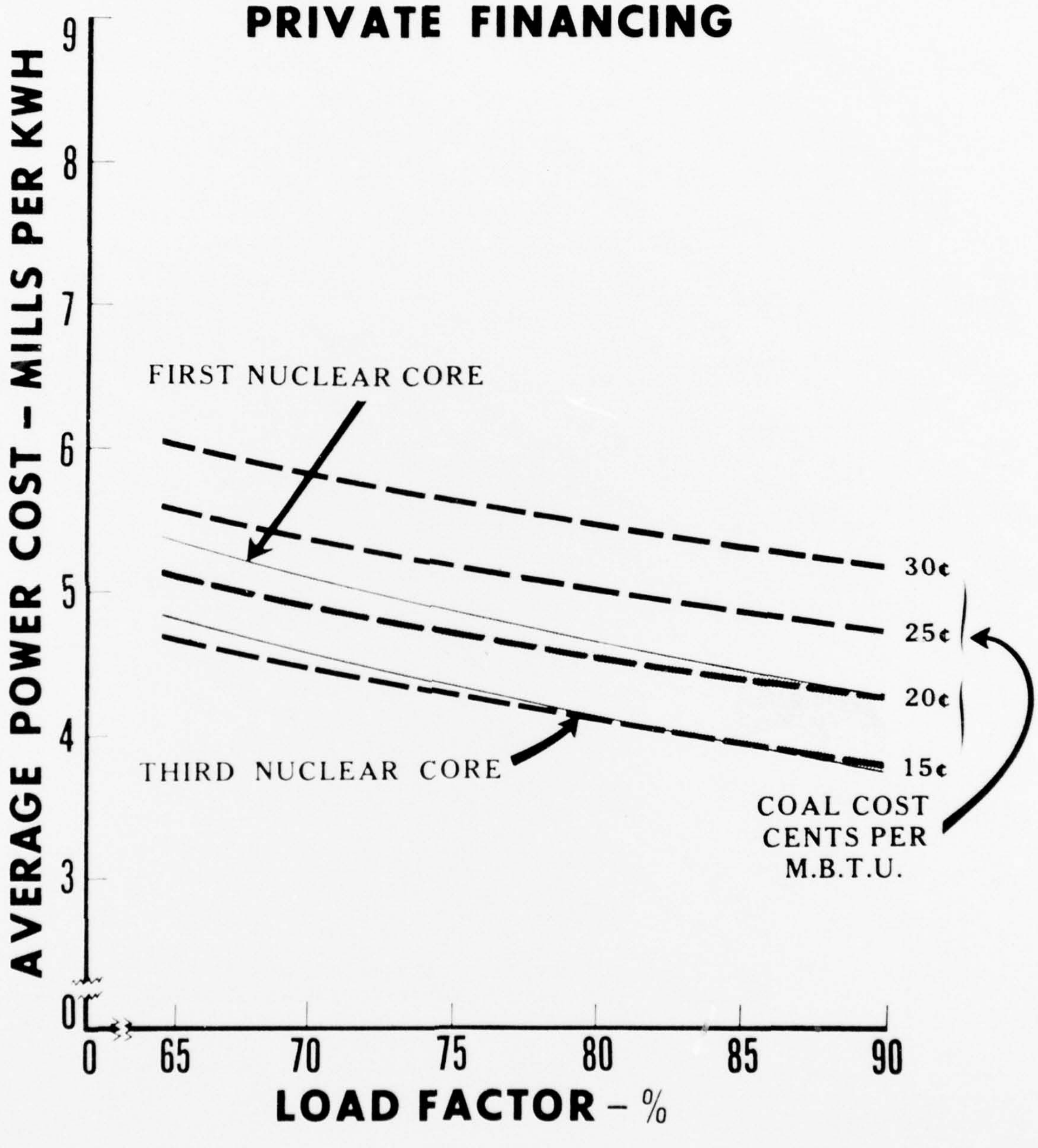
1/ Plant retired 12-27-65

2/ 385,000 kw unit added in 1967

Plate III-B

COMPARATIVE COST OF POWER FROM 600 MW NUCLEAR AND COAL-FIRED PLANTS

PRIVATE FINANCING



From a Presentation by F. Stewart Brown, Chief, Bureau of Power, FPC - TRENDS IN THE DEVELOPMENT OF NUCLEAR POWER

Plate IV

COMPARATIVE COST OF POWER FROM 100 MW NUCLEAR AND COAL-FIRED PLANTS

MUNICIPAL FINANCING

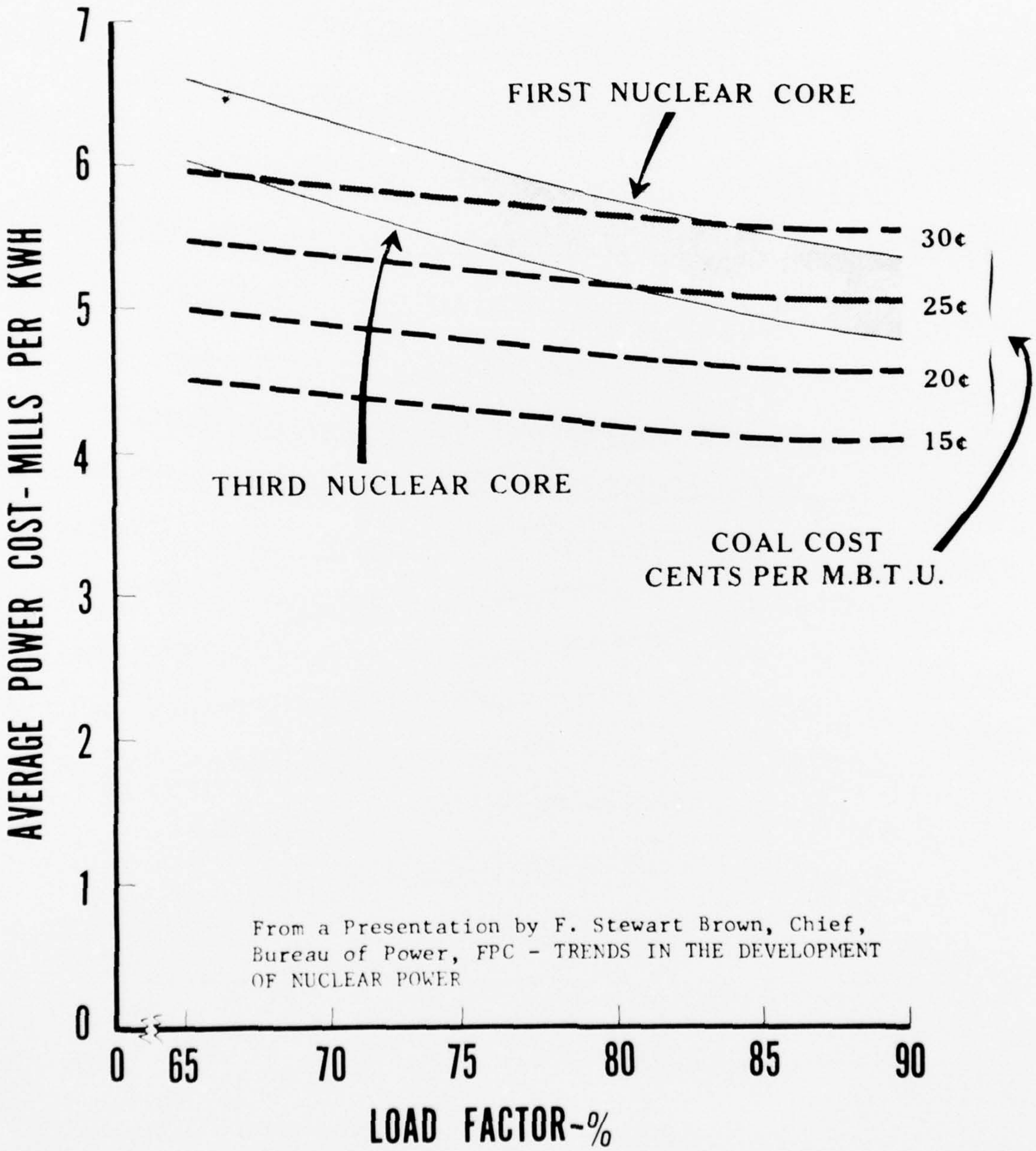


Plate V

ESTIMATED NUCLEAR FUEL COSTS

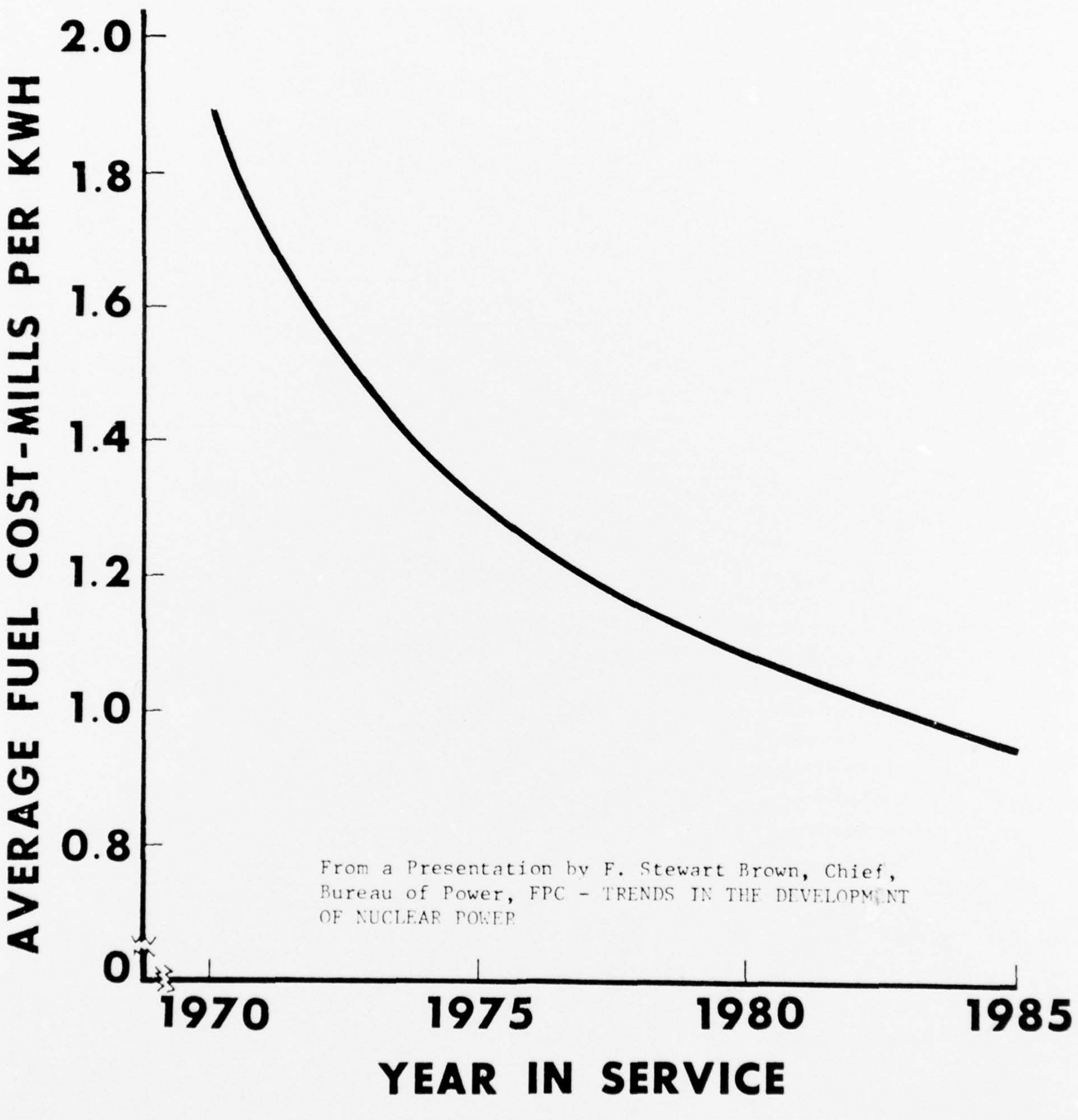


Plate VI

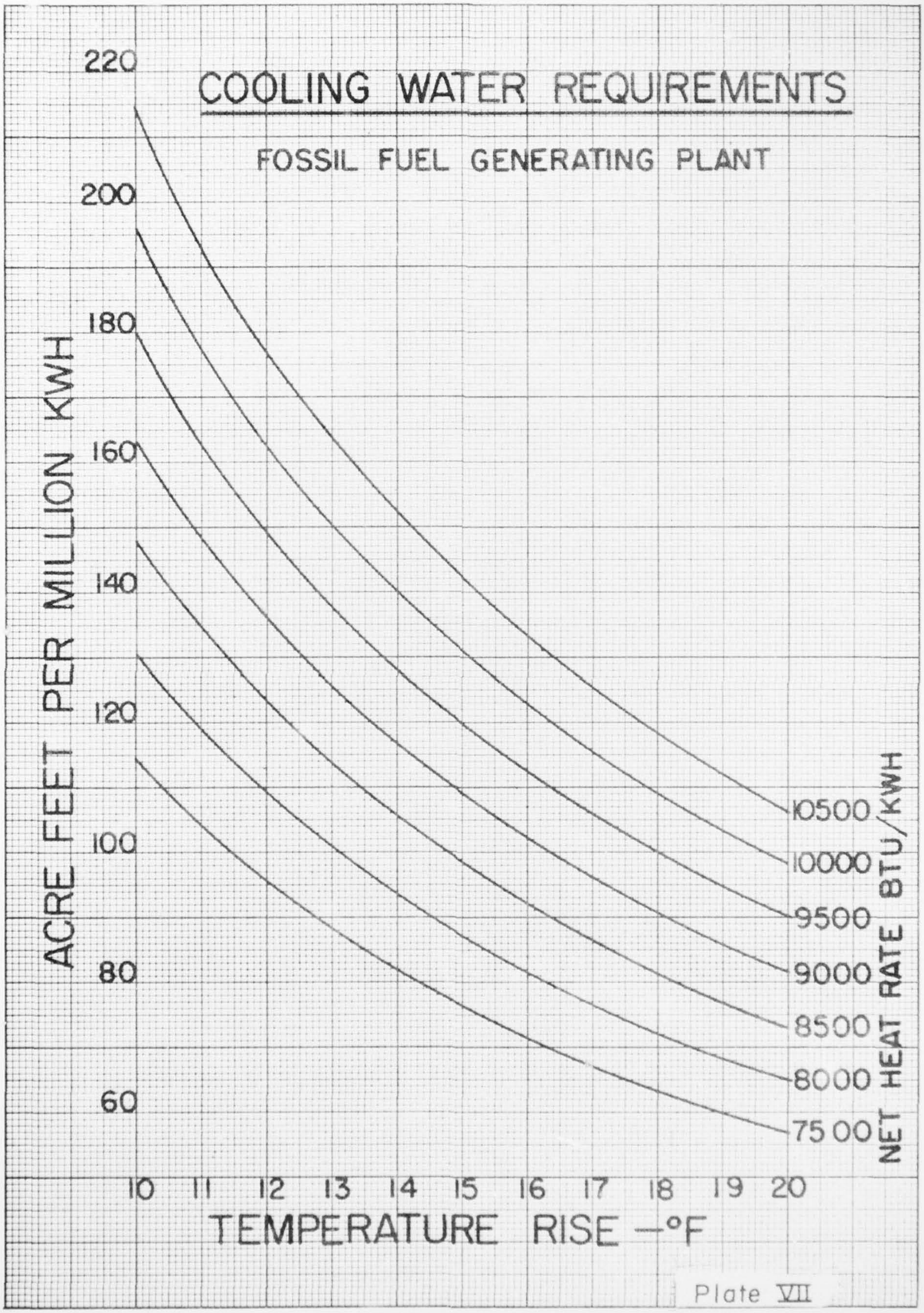
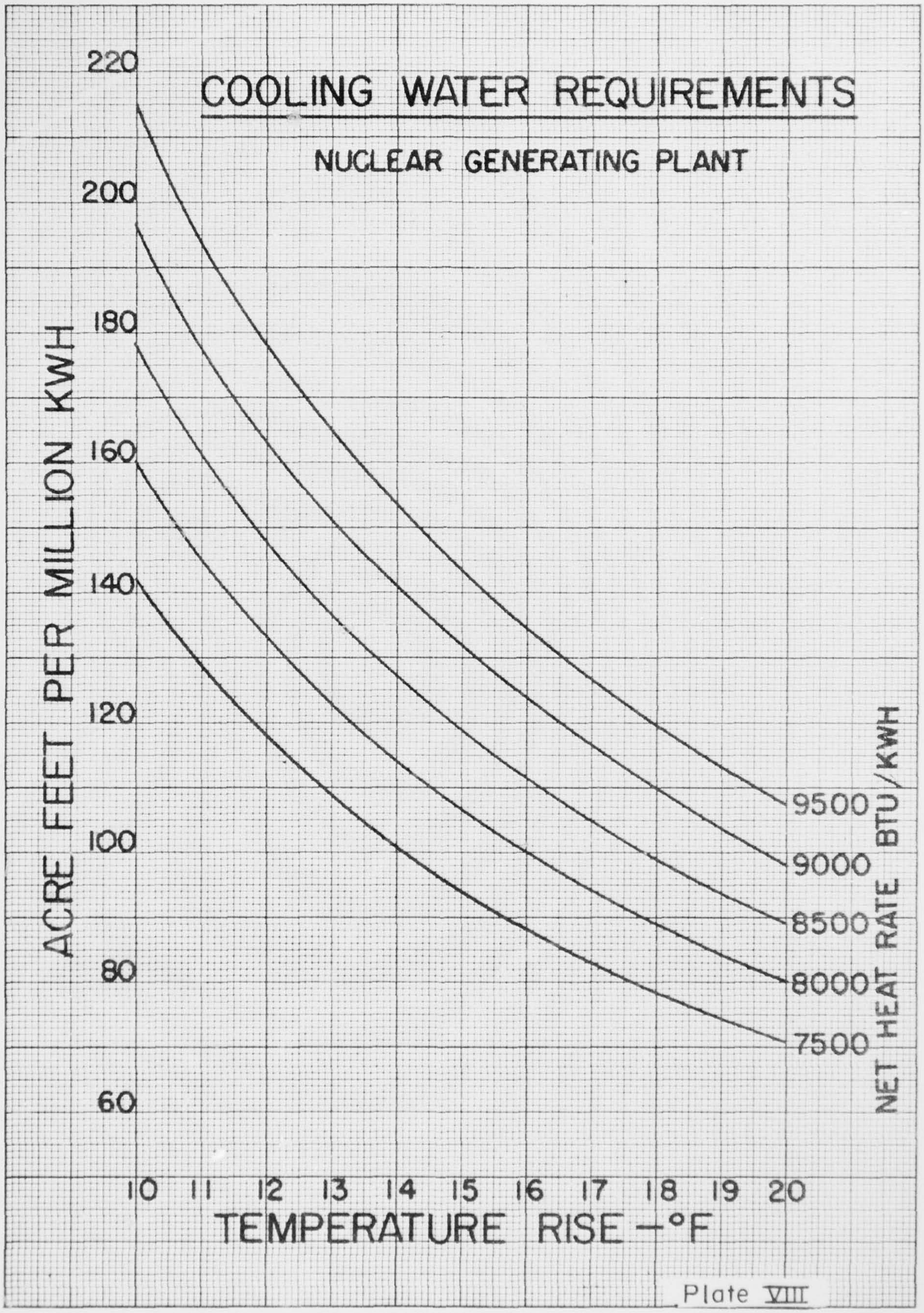

COOLING WATER REQUIREMENTS
FOSSIL FUEL GENERATING PLANT
ACRE FEET PER MILLION KWH
220
200
180
160
140
120
100
80
60
10500
10000
9500
9000
8500
8000
7500
NET HEAT RATE BTU/KWH
10 11 12 13 14 15 16 17 18 19 20
TEMPERATURE RISE —°F

Plate VII



COOLING WATER REQUIREMENTS
NUCLEAR GENERATING PLANT
ACRE FEET PER MILLION KWH
220
200
180
160
140
120
100
80
60
10 11 12 13 14 15 16 17 18 19 20
TEMPERATURE RISE — °F
9500
9000
8500
8000
7500
NET HEAT RATE BTU/KWH
Plate VIII

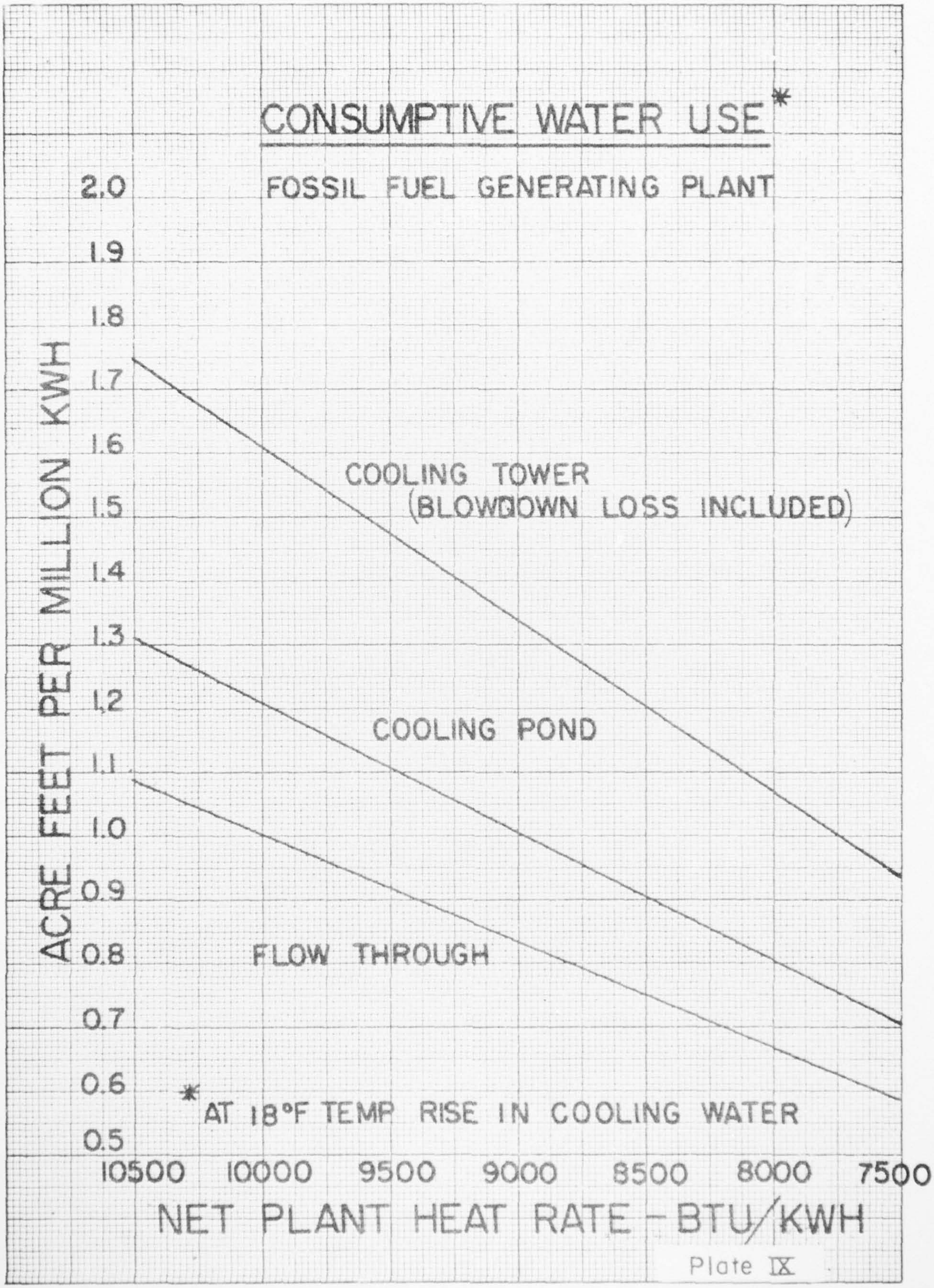

CONSUMPTIVE WATER USE*
FOSSIL FUEL GENERATING PLANT
ACRE FEET PER MILLION KWH
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
COOLING TOWER
(BLOWDOWN LOSS INCLUDED)
COOLING POND
FLOW THROUGH
*AT 18°F TEMP RISE IN COOLING WATER
10500
10000
9500
9000
8500
8000
7500
NET PLANT HEAT RATE - BTU/KWH

Plate IX

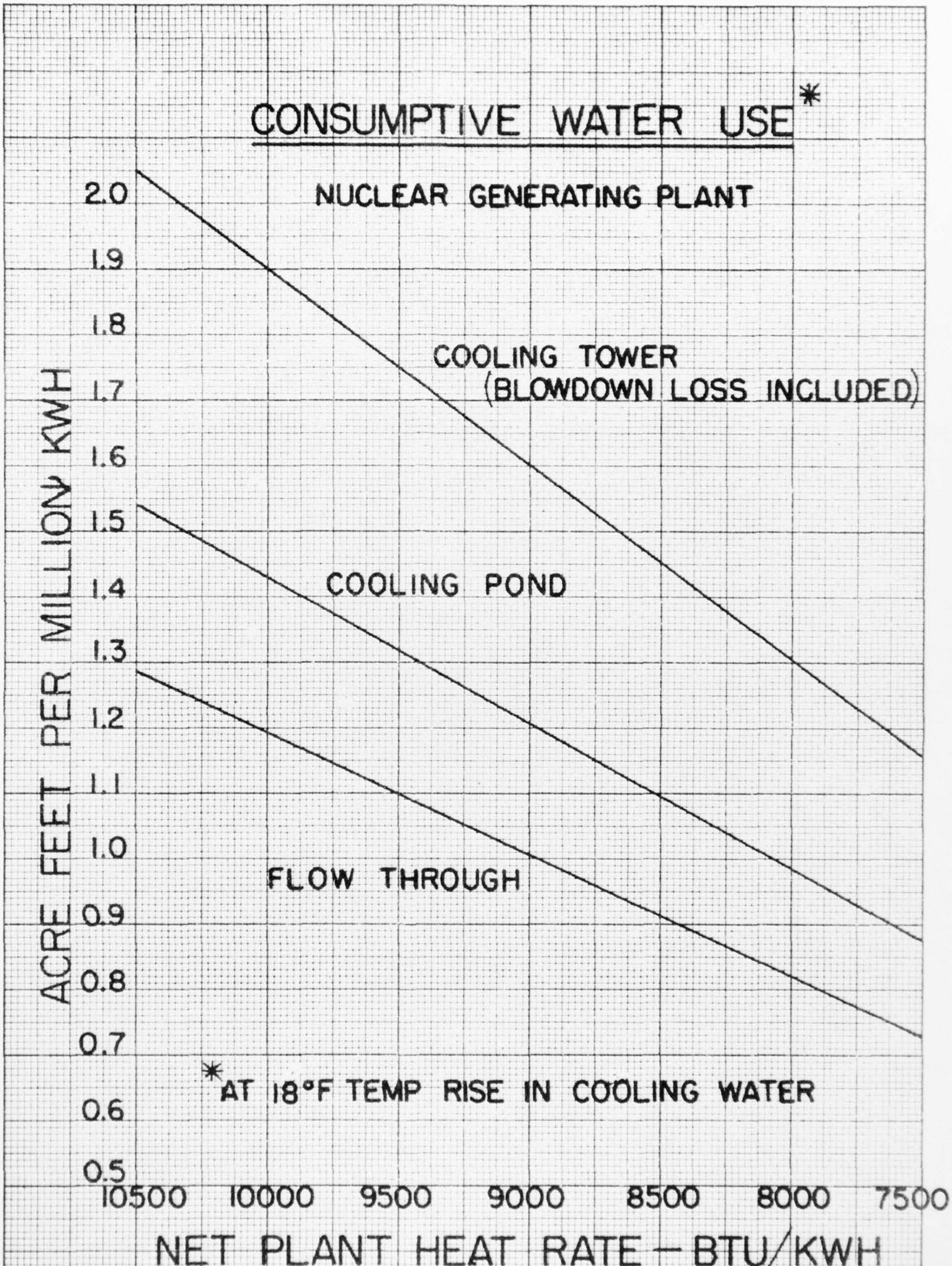

CONSUMPTIVE WATER USE*
NUCLEAR GENERATING PLANT
COOLING TOWER
(BLOWDOWN LOSS INCLUDED)
COOLING POND
FLOW THROUGH
*AT 18°F TEMP RISE IN COOLING WATER
ACRE FEET PER MILLION KWH
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
10500
10000
9500
9000
8500
8000
7500
NET PLANT HEAT RATE — BTU/KWH

Plate X